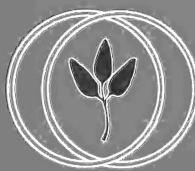


Australasian Plant Conservation

Bulletin of the Australian Network for Plant Conservation Inc



Volume 29 Number 1 June – August 2020



Featuring articles on plant
responses to fire, seed biology,
orchids, translocation and more!

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Front cover: Usual habitat of Sand Spurge.
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Australasian Plant Conservation is a forum for
information exchange for all those involved in
plant conservation: please use it to share your
work with others. Articles, information snippets,
details of new publications or research and
diary dates are welcome. General articles on
any plant conservation issue are most welcome.

The deadline for the **Spring 2020** issue is
1 August. If you are intending to submit an
article or wish to discuss possibilities, please
email the editor the editor, Heidi Zimmer:
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From the editor

HEIDI ZIMMER

Welcome to the Winter 2020 issue of Australasian Plant Conservation. This issue opens with the address from Linda Broadhurst (the recent past-president of ANPC) given to the ANPC Annual General Meeting at the end of 2019. Better late than never, it gives an overview of the important work of ANPC in 2019 and into 2020. We then move to regular articles, beginning with those focussed on plant responses to fire. Michele Kohout *et al.* describe a post-fire upsurge of the aggressive pioneer weed *Phytolacca octandra* (Inkweed) around Mallacoota in East Gippsland, Victoria, and efforts taken to control it. Staying in Victoria, Annette Muir *et al.* provide important observations of seed production and seedling recruitment of the serotinous obligate-seeding shrub *Banksia spinulosa* var. *cunninghamii* (Hairpin Banksia), in relation to time since fire and to consider the potential impacts of the 2019–2020 bushfires. Staying on the theme of fire, but moving to NSW, in the next article Ian Baird and Doug Benson describe impacts of longwall coal mining on the threatened shrub swamps of the Newnes Plateau, as revealed by the recent bushfires.

Next, we have four plant conservation stories from NSW. First, Laura Canacle and colleagues tell us the stories of three Midge Orchids (*Genoplesium* spp.), concerns over declining numbers and the effects of this years' summer-autumn rains. Next Justin Collette and Nathan Emery present their new project looking at how threatened ecological communities in the Brigalow Belt south bioregion respond to seasonal fluctuations and rainfall events, and tell us why they are collecting seeds for research and conservation. This is important work

and we look forward to hearing more results from Justin and Nathan as results begin to roll in. Returning to a favourite theme for APC, Nicola Booth and Mark Hamilton describe the translocation of *Euphorbia psammogeneton* (Sand Spurge) including at one site due to declines resulting from storm erosion. Moving from the coast to inland NSW, Darren Shelly and Susan Lamb detail their survey for *Dentella minutissima*.

In his article 'Nature needs people, but people need connection' Jacob Mills takes us somewhere completely different: into the world of microbiota which, while essential to life on earth, many of us rarely think about. A/Prof Paul Adam, the past editor of APC, inspired me to get in touch with Jacob, after reading his recent articles on the influence of restoration on the microbiota, and flow on effects for human health. If you need more reasons for plant conservation and restoration in urban environments, the findings of Jacob and colleagues detailing the effects of the environment on microbiota, and the effects on human health will give you plenty!

Next, Amelia Martyn Yenson introduces us into her work around reviewing and updating the ANPC's Germplasm Guidelines. Everyone involved with *ex situ* plant conservation will be following this important project with interest. This is followed by news from the Australian Seed Bank Partnership, a profile of new ANPC committee member Stephen Bell, a review of the new edition of Plant Names and ANPC News. Phew! Time to grab a hot cuppa, sit back and enjoy the read.

Out-going President's Report

To the Annual General meeting, 20 November 2019

LINDA BROADHURST

ANPC President, Australian Network for Plant Conservation Inc. Email: anpc@anpc.asn.au

I am very proud to say that 2019, our 28th year, has been a highly successful year for the ANPC and our role as Australia's key plant conservation organisation. Over the first half of the year, we successfully negotiated funding with the NSW Environmental Trust for our new Healthy Seeds Project which commenced in September (2019) and will run for 18 months. This project aims to deliver an evidence-based roadmap to secure a reliable, genetically-appropriate, native seed supply in NSW for restoration. We will also be undertaking a long-overdue update of the Florabank Guidelines for best practice native seed collection and use as well as an audit and investigation into past and current Seed Production Areas (SPAs). A consortium of partners from across the native seed and ecological restoration sectors has been established to oversee the project including Greening Australia, CSIRO, Royal Botanic Gardens Sydney, NSW Department of Planning, Industry and Environment, the Australian Association of Bush Regenerators, the Australian Seed Bank Partnership, and the Society for Ecological Restoration Australasia.

We are also extremely excited to announce that we were awarded an Ian Potter Foundation Environment and Conservation grant to review and update the ANPC's Germplasm Guidelines over the next two years. Through this grant we will be able to comprehensively update one of our flagship publications '*Plant Germplasm Conservation in Australia – strategies and guidelines for developing, managing and utilising ex situ collections*'. These Guidelines remain the definitive Australian standard for native seed and regenerative plant material collection, storage and use following publication in 2009. Since that time, seed biology research has progressed significantly and to ensure that the latest information is passed onto practitioners and land managers, we will bring together leading experts in seed biology research and practice from across Australia to review and rewrite the Guidelines. By continuing to incorporate updated scientific knowledge in our publications we are ensuring that Australia's seed sector has the necessary skills and knowledge. We will establish a steering committee and employ a project manager to co-ordinate the revision, with a specialised two-day consultation workshop with germplasm experts (*Editor's note: A report from the recently appointed project manager, Amelia Yenson, is included in this issue*). We will also develop new training materials which will be delivered at four stakeholder workshops across Australia. For those unable to attend these events,

online training and innovative video content will be produced to widely promote and promulgate the new Guidelines and its content.

The ANPC has again been involved in submissions to government either through participation in workshops or commenting on proposed legislative changes or guidelines. On 12 July, we commented on and endorsed a Submission to the draft National Environmental Biosecurity Response Agreement submitted by the Invasive Species Council, along with many other environmental organisations, which was a follow up to our 2017 submission. The ANPC has also been an active participant in the environmental biosecurity review through participation at several meetings and roundtables by Bob Makinson and myself. The ANPC is among the few plant-oriented NGOs to have been closely engaged in this environmental biosecurity process at the national level, and it needs to become one of our core areas of advocacy.

The ANPC made a submission on 30 September 2019 on the Priority List of exotic environmental pests and diseases recently issued by The Commonwealth Department of Agriculture. This is a significant step in the slow process of building greater awareness and capacity for Australia's environmental biosecurity. The public comment period for the list has now closed, but the list remains available pending its finalisation. The ANPC is looking to bring members concerned about environmental biosecurity issues into closer contact with each other, to give us greater capacity on this side of our work. If you are interested in networking on this, please email the office with subject line 'Enviro biosecurity'.

The ANPC continues to maintain its strong involvement in promoting awareness of the plant pathogen Myrtle Rust (*Austropuccinia psidii*) threat to Australia's biota, and advocating for action. This has been a focus of activity by our Vice-President Bob Makinson since 2010. We are the only organisation, government or non-government, to have rolled out a national awareness program of workshops, collaborating with many agencies. This year, we published the new updated Global Host List for Myrtle Rust on our website, by Julia Soewarto and co-authors. The new Global Host List shows that the host range now stands at 480 nominate species (524 taxa when subspecies are counted separately, as they are in Australian conservation practice). This host range,

and the rapid geographic spread of one strain of the pathogen, demonstrate that Myrtle Rust disease is now a major threatening process for the Myrtaceae family on a global scale.

The Australian community continues to demonstrate strong interest and support for plant conservation. To meet these expectations the ANPC is playing a key role in facilitating and communicating plant conservation initiatives and information across Australia. This is reflected in the ongoing participation of land managers, government departments, industry, the volunteer conservation movement and the broader community in ANPC workshops and conferences as well as the requests we receive from other organisations and government agencies to participate in and comment on various flora conservation initiatives.

While I continue to be greatly impressed by the dedication and breadth of knowledge of ANPC members, we still face many significant challenges. We need to ensure that we continue to effectively promote the inherent value and cultural significance of our unique and wonderful flora to the broader Australian community and remain true to our core business of facilitating Australian plant conservation, threatened species recovery, ecological restoration and remnant vegetation management.

2018 APCC12 Conference

The ANPC's flagship event is the biannual Australasian Plant Conservation Conference and our 12th conference was held in Canberra on 11–15th November 2018.

This conference brought together a diverse range of participants including botanists, geneticists, ecologists, practitioners, land managers, and on-ground plant conservation managers from around Australia to review and highlight plant conservation achievements and challenges. The theme for the conference was "*Moving House – A new age for plant translocation and restoration*". Together we explored and discussed recent advances and latest scientific findings for successful threatened plant translocations and restoration across Australia. Species translocations have been an important conservation approach for more than two decades to save threatened species from extinction. With no foreseeable reduction in threats from climate change, urban and agricultural expansion and intensification, and invasive pests and diseases, plant translocations and restoration will continue to be an important component of plant conservation into the future.

I would like to thank all the conference sponsors and the conference organising committee: Josh McGregor, Damien Wrigley, David Coates, Lucy Commander, Chantelle Doyle, Nicki Taws, Jasmyne Lynch, Jo Lynch and Martin Driver for their huge effort in helping me coordinate the conference. Particular mentions go to Robert Hawes and Chris Ikin in the ANPC office as well as

other ANPC volunteers, and Josh McGregor from CANBR who all worked tirelessly to ensure that the conference ran smoothly.

Workshops, Projects and Outreach

One of our major achievements in 2018 was the publication of the 3rd edition of the ANPC's '*Guidelines for Translocation of Threatened Plants in Australia*', in association with the Threatened Species Recovery (TSR) Hub and the ACT Government, and launched by the Threatened Species Commissioner Dr Sally Box at the APCC12 Conference. This new edition of the Guidelines is essential reading for all those involved in translocation projects both in Australia and elsewhere. Many thanks go to Lucy Commander, Dave Coates, Cathy Offord, Bob Makinson and Maria Matthes for the successful completion of this project as well as to the authors and experts who willingly gave their time to this important project.

During 2019 we widely distributed and promoted the new Guidelines, including through three short videos that are available on our website at https://www.anpc.asn.au/translocation_guidelines_review/, to keep Australia at the cutting edge of this important technique used in the fight against plant extinctions. In addition, twenty-six threatened plant translocation case studies were published on our website at <https://www.anpc.asn.au/translocation-case-studies/>.

Through support from the Threatened Species Recovery Hub, the Western Australian and South Australian governments, and the University of Adelaide, we have held two Threatened Plant Translocation Workshops this year in Perth and Adelaide. A total of 24 speakers presented to 108 participants representing volunteer groups, universities, landcare groups, government departments, local councils, NGOs, consultancies and a winemaking company. Material in the new Translocation Guidelines was presented, as well as local translocation case studies, followed by lively panel discussions. Thank you to our sponsors and all those who presented at the workshops. Selected presentations are available on the ANPC website here <https://www.anpc.asn.au/wa-threatened-plant-translocation-workshop/> and here <https://www.anpc.asn.au/sa-threatened-plant-translocation-workshop/>.

The ANPC collaborated with the Australian Association of Bush Regenerators (AABR) to co-host the Seeds for the Future Forum held in Sydney on 8 October 2019. This one-day forum brought together people from the bush regeneration, revegetation, nursery and landscape architecture sectors to set the scene for future collaborations, and introduce the Healthy Seeds project and an outline of the National Native Seed Survey findings. It included in-depth discussion and practical case studies for optimising the conservation of remnants, through identifying the issues and suggesting solutions

for improved seed supply across the Greater Sydney area. One of the outcomes of the forum is a 'Commuque from the NSW restoration industry' which calls upon State and Federal governments to direct incentive funding to biodiversity restoration and the infrastructure required to support it.

We are currently collaborating with the Australian Seed Bank Partnership on planning the Australasian Seed Science Conference (*Editor's note: now postponed until September 2021*). The conference will be covering the following themes:

- Seed biology and evolutionary ecology – Unlocking the challenges of germination, dormancy and seed ecology in a changing world.
- Seed sourcing and end-use – Considering genetic diversity, restoration and translocations as well as sector specific approaches to seed conservation and use.
- Seed and gene bank management – The ins and outs of managing *ex situ* seed banks and gene banks and the methods for maximising seed quality and longevity.
- Seeds in culture and society – Sharing stories and learning about cultural seed use, including collaborations between traditional use and *ex situ* seed banks and gene banks.

ANPC Project Manager, Martin Driver has continued to implement the ANPC's networking and communications role between researchers and practitioners for Stage 2 of the Bringing Back the Banksias project from the Norman Wettenhall Foundation. It has enabled further *Banksia marginata* collections to be taken from relict populations or trees from Kangaroo Island, North East Victoria, Southern NSW, Upper Murrumbidgee and New England for analysis in conjunction with The Royal Botanic Gardens Sydney '*Restore and Renew*' project. Genetic analysis is still to be completed and cross referenced with sub-samples from the previously completed Victorian projects. Once analysis is completed, a workshop to communicate findings and implications is planned for 2020. This year he has presented at three workshops for this project. Due to the effects of the current drought and limited funding, no plant ID or seed collection workshops have been held this year.

Between October 2016 and April 2017 the ANPC undertook a survey of the Australian native seed sector, which reported dwindling seed supplies and a decline in expertise and training. Initial survey results were disseminated at a workshop held at the APCC11 2016 conference in Melbourne. Survey results have been collated and interpreted over the last two years with the final report to be published in early 2020. The project team is Nola Hancock (Department of Biological Sciences, Macquarie University), Paul Gibson-Roy (Kalbar Resources), Martin Driver and myself. Thanks to Nola, Paul and Martin for their continued efforts to

helping to understand this critical and complex part of plant restoration. The survey results presented at the 2016 workshop are available on the ANPC website <https://www.anpc.asn.au/seed-survey-and-workshop/>.

Over the past 12 months, the ANPC has continued its collaboration with the Orchid Conservation Program at the Royal Botanic Gardens Victoria (RBGV) on two projects. The '*Saving the Threatened Audas Spider-orchid (Caladenia audasii) from extinction*' project funded by DELWP in 2017 has resulted in seed collection and propagation of seedlings, hand pollination of wild plants, plant surveys and pollinator baiting, and the construction of an exclusion fence to protect newly discovered plants from grazing kangaroos and rabbits. This project will finish in June 2020 with the re-introduction of 200 plants. In 2018 DELWP also funded a similar project '*Saving the Brilliant Sun Orchid (Thelymitra mackibbinii) from extinction*'. This project has been undertaking plant and pollinator surveys as well as the construction of two exclusion fences and signage. Community volunteers have been assisting with the surveys and will reintroduce 600 propagated seedlings in winter 2021.

Our outreach efforts continue to expand through social media with the regular sharing of news and events in plant conservation via Twitter, Facebook, Instagram and LinkedIn. Our monthly email newsletter *ANPC News* continues to reach at least 630 subscribers. A new look ANPC website was launched in early 2019 which has significantly improved our information delivery and online shopping procedures and membership form. A big thank you to Heidi Zimmer for assisting us with this transition.

Our quarterly bulletin, *Australasian Plant Conservation (APC)*, has continued to publish high-quality articles relevant to a broad range of plant conservation practitioners and managers, under the editorship this year of Heidi Zimmer and assistant editors Nathan Emery and Selga Harrington. This year, there have been two editions on the Translocation of Threatened plants, papers from the 12th Australasian Plant Conservation Conference and a focus on the NSW Saving our Species program. We sincerely thank Heidi, Nathan and Selga for their efforts over the past year in ensuring that APC continues to be a quality and well-respected publication communicating Australasian plant conservation issues. Thank you also to the many authors who have contributed to these editions this year.

Staffing

In June 2019, Dr Lucy Commander completed her employment as Project Manager for the review, publication and promulgation of the third edition of the ANPC's *Guidelines for the Translocation of Threatened Plants in Australia*. I would like to thank Lucy for her excellent work. Lucy's dedication to this project was immense. She consulted with more than 30 experts

from across Australia to ensure that the Guidelines were underpinned by the latest scientific findings. However, I am very glad to say that Lucy has not left us just yet, as she has now been employed as the Project Manager for the Florabank Guidelines review under the Healthy Seeds project and has hit the ground running after starting in September 2019.

In July 2019, Martin Driver was further employed as the Healthy Seeds Project Manager where he will coordinate and manage the Healthy Seeds project, and oversee the SPA audit and Investigation Reports, Florabank Guidelines update and development of the roadmap. He will also coordinate consultation and liaison with stakeholders, consortium members, other reference groups, experts (scientists and practitioners) and community representatives from a range of organisations.

Many thanks to our Business Manager Jo Lynch, who continues to work above and beyond the call of duty for the ANPC. Her dedication, advice and support make my role and the work of the Committee much more effective and ensures that the ANPC continues to function as a highly respected conservation organisation. Also sincere thanks to our office volunteers this year, Chris Ikin and Robert Hawes, who have helped enormously with various administrative and financial tasks.

I am grateful to all the Committee members for their tremendous support over the year. All of the Committee members have significant commitments outside the ANPC, and it is often challenging to devote the time required to be active committee members. The involvement in the committee by all members is a clear demonstration of their dedication to the ANPC and its goals in improving plant conservation.

I would especially like to thank Chris Ikin, Kate Brown, Maria Matthes, Selga Harrington and Kylie Moritz who are leaving the committee this year, as well as Bob Makinson who is stepping down as Vice President but re-standing as an Ordinary Member, and I sincerely thank them for their time and support over the last four years of my President-ship. I too am resigning this year as my term is up and I am extremely thankful to have had the opportunity to work with a group of people that are so passionate and dedicated to Australian Plant Conservation.

Funding

Our financial situation will be reported on in detail separately at the AGM but some of our key sources of income this year have included:

- NSW Environmental Trust Healthy Seeds project.
- Ian Potter Foundation Environment and Conservation grant for the review of the Germplasm Guidelines.
- Threatened Species Recovery Hub, Department of Biodiversity Conservation and Attractions,

South Australian Murray-Darling Basin Natural Resources Management Board and the Environment Institute at the University of Adelaide for two plant translocation workshops.

- Normal Wettenhall Foundation biodiversity conservation grant for Stage 2 of the *Bring Back the Banksias Project* – coordination, communication and workshop.
- Biodiversity On-ground Action 2017 – Community and Volunteer Action Grant (Victoria) for "Saving the threatened Audas Spider-orchid (*Caladenia audasii*) from extinction".
- Biodiversity On-ground Action 2018 – Community and Volunteer Action Grant (Victoria) for "Saving the Brilliant Sun Orchid (*Theelymitra mackibbinii*) from extinction".
- Memberships and donations.

I would like to thank Jo Lynch and Martin Driver, as well as committee members, for their efforts in seeking projects and grants – while not every application is successful, we rely heavily on their efforts to continue to seek funding to support our key activities.

The coming year

2020 will be a busy year for the ANPC undertaking the following activities:

- Implementing the Healthy Seeds Project including producing the Roadmap and Florabank Guidelines.
- Reviewing and revising our Germplasm Guidelines.
- Planning and holding the 13th Australasian Plant Conservation Conference.
- Launching the National Seed Supply Survey Report.
- Seeking additional funding for further translocation workshops. The ANPC is available to run workshops based on the new Translocation Guidelines anywhere in Australia. Registration fees depend on the amount of funding available (either from an institution or a successful grant application) to cover such expenses as catering, venue hire and ANPC staff time and travel. Please contact the ANPC for further information and request a quote, or to collaborate on a grant application.
- Completing Stage 2 of the Bring Back the Banksias project.
- Continuing the two orchid projects with RBGV.

I have thoroughly enjoyed my time as President over the last 4 years. It has been a pleasure and a privilege to work with all of you and for an organisation that does so much for plant conservation in Australia. I see an ongoing and important future for the ANPC as it continues to play a key role in plant conservation across Australia and the region more broadly.

Battling an “aggressive pioneer” after fire: *Phytolacca octandra* (Inkweed)

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Bushcare Mallacoota has been controlling seedlings of the exotic plant *Phytolacca octandra* L. (Phytolaccaceae) (Inkweed) since fires in January 2020. This plant was first recorded in small numbers in urban areas of the township about 15 years ago and ongoing control has been by hand removal. Since the recent fires, there has been large-scale germination of this weed, including spread into bushland areas, where it had not been previously recorded (Figure 1).

Inkweed is native to tropical South and Central America. In Australia it is found along roadsides, creeklines and in disturbed areas, including cleared vacant blocks. This species is a leafy, short-lived perennial plant growing up to 2 m tall with a tuberous taproot and long fibrous lateral roots. Leaves are elliptic, 16 cm long with an entire margin, the petiole is 40 mm long. It produces spikes of small greenish-white flowers followed by red succulent berries with a fruit length of 5–9 mm. Up to eight seeds, each 2 mm long, are produced per fruit (Walsh and Entwistle 1999). When ripe, the berries produce a red ink-like juice, which has been used as a dye. It can produce fruit year round (Wotton and McAlpine 2015).

The seeds are eaten by birds (especially Silvereyes and Satin Bower Birds) and Foxes, which spread the seed in their droppings. The digestive juices of birds help to dissolve the hard seed coat, allowing germination when they are passed (Floyd 1976). The seeds have recorded

96% viability after passing through Silver-eyes (Stanley and Lill 2002).

Inkweed seeds germinate poorly unless heated and may therefore remain in the soil seed bank until this occurs (Floyd 1966). It appears to be favoured by low intensity fire (Floyd 1976). It is an initial coloniser following fire, emerging in large numbers, maturing quickly and producing many seeds, such that Floyd (1976) described it as an “aggressive pioneer”. It is possibly stored in the soil seed bank for up to 14 years (Floyd 1976). The reported shade intolerance of inkweed may mean that it could gradually be replaced by a suite of perennial exotic species that invade after fire (Floyd 1976, Thomson and Leishman 2005; it could also be outcompeted by recovering natives but, to date, there is no evidence of this). However, more research is needed into this succession since the broad leaves suggest that it can tolerate some shading. BushCare Mallacoota have observed that pre-fire plants were growing on disturbed, vacant land out in the open. Post-fire germination has mainly been observed under burnt trees in shade (Figure 2), particularly in damp poorly drained areas and gullies.

Interestingly, this species was declared a noxious weed in Australia as early as 1907–1918, but is no longer declared noxious, most likely because it is present across a large geographic range and hence enforced control is no



Figure 1. Young *Phytolacca octandra* seedlings, Mallacoota.
Photo: Pat Couper



Figure 2. *Phytolacca octandra* infestation in burnt area,
Mallacoota. Photo: Pat Couper

longer warranted (Johnson 2013). In Victoria, however, it is classified as an environmental weed with a high risk rating for control or eradication (White *et al.* 2018). It occurs in every state and territory in Australia, except the Northern Territory, with the main distribution on the east coast of New South Wales and has been recorded at 200 to 1000 m in elevation (Atlas of Living Australia) (Figure 3).

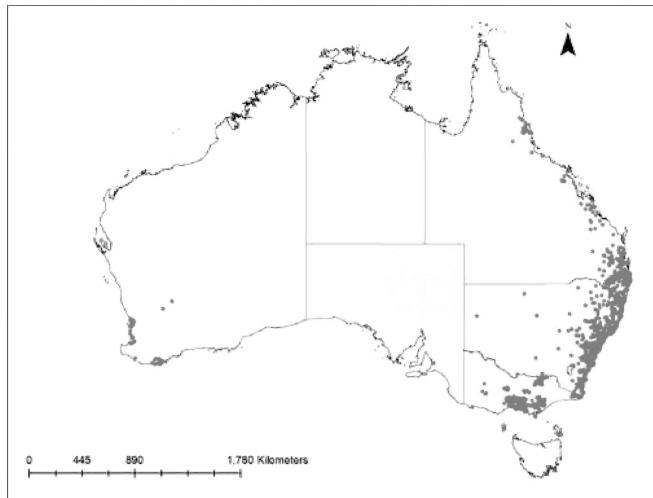


Figure 3. Distribution of *Phytolacca octandra* in Australia (Atlas of Living Australia).

Bushcare Mallacoota are controlling the species using the herbicide glyphosate (Bayer RoundUp®) plus a surfactant. The results of this control have been very effective to date on seedlings and young plants. Larger, flowering plants are also affected by treatment with herbicide, but it is too soon to know if they will die or re-sprout. One site with a dense germination of Melaleucas has been left untreated as a control to determine if the Inkweed will be outcompeted in time. Young seedlings may be manually removed but older plants, which develop a strong taproot, tend to break off and regrow. It has been observed to be a fast grower such that, within a month of germination, it can start to flower (Figure 4). The weeding group had not considered this to be a problem weed in Mallacoota until this recent fire occurred and they hope to control the outbreak before seed-set. This is a significant observation and it is imperative that the young seedlings of this species are identified and removed before it can outcompete native regeneration.



Figure 4. Flowering *Phytolacca octandra*, two months after fire. Photo: Pat Couper.

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Hairpin Banksia: a widespread plant threatened with decline by frequent fires

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Background

The extensive bushfires in south-eastern Australia during the 2019–2020 summer significantly impacted many threatened plant taxa, including species listed under legislation. However, the life history characteristics of many unlisted serotinous obligate seeders make them vulnerable to frequent fires, especially when combined with increasing temperatures and decreasing rainfall due to climate change.

Banksia spinulosa var *cunninghamii* (Hairpin Banksia) is one such taxon vulnerable to local extinction from short fire intervals because: adult plants are killed by fires; time to reproductive maturity is relatively long; and canopy-stored seed does not persist in the soil. Almost the entire range of Hairpin Banksia in the East Gippsland region of Victoria was within the boundary of the 2019–2020 bushfires (DELWP 2020). These populations, along with small populations in far southeast NSW and southwest of Sydney, are considered taxonomically distinct from others in the *B. spinulosa* complex (Stimpson *et al.* 2016). The species is at increased risk of decline in areas where fires in the preceding ten years overlap with the 2019–2020 fires, because there are unlikely to be sufficient seeds available for recruitment to replace the fire-killed adults.

This article summarises Victorian Hairpin Banksia reproduction between 2014 and 2017 in relation to fire intervals, to determine time to reproductive maturity and seedling establishment. It compares the extent of the 2019–2020 bushfires to previous fires in the modelled distribution of Hairpin Banksia in Victoria, to assess the potential impact of the fire and subsequent recovery. Some implications for management are discussed.

Methods

Seed production and seedling recruitment

Hairpin Banksia seed production and seedling recruitment were studied in two areas of mixed Eucalypt forest – east of Melbourne and East Gippsland. Sites represented a sequence of time since fire spanning five to 35 years (DELWP 2020).

Cones with closed follicles (as a proxy for viable seeds) were counted on live adult plants for three years at the

two study areas (Figure 1). In 2014, 295 individual plants were tagged and sampled, and 154 of these plants were sampled again in 2015 and a different subset of 160 in 2016.

Seedling recruitment was measured in spring 2016 at sites which had been burnt at low severity within the previous six to 18 months. We measured the number of seedlings for each of 200 dead adult plants, within the radius of the original canopies (Figure 1).



Figure 1. Hairpin Banksia cone with closed follicles; seedling six months after fire. Photos: Annette Muir

Analysis for both the probability of individual Hairpin Banksia carrying viable cones, and the average number of viable cones carried by individuals was done with a hurdle model in a Bayesian framework (Zeileis *et al.* 2008) to account for the large number of zero observations. For seedling recruitment, a simple calculation was made of the average number of seedlings per adult plant, with standard error (SE).

Spatial data resources

Hairpin Banksia records and a habitat model were overlaid with fire severity mapping within the 2019–2020 fire boundary and Victoria Government fire history data in East Gippsland (DELWP 2020). The Victorian Biodiversity Atlas was used to identify all records of Hairpin Banksia (1979–2017) with location precision better than 50 m. The species distribution model for Hairpin Banksia had previously been developed by the Arthur Rylah Institute (DELWP), using a multi-objective regression-tree analysis of plant quadrat data to jointly model flora species using a suite of climate, terrain and remotely sensed environmental variables. Fire severity was mapped using pre- and post-fire Sentinel 2 imagery, with Random Forest classification of severity classes based on a large dataset of human-classified severity samples from previous bushfires, as described in Collins *et al.* (2018). Polygons of fire boundaries for all recorded bushfires and planned burns occurring in East Gippsland from the 2009–2010 season to 2019–2020 were collated.

Results

Seed production and seedling recruitment

About two-thirds of plants produced no cones in the first decade after fire. Up to nine years after fire, the probability of an individual plant having at least one viable cone was 37.7% (95% Credible Interval (CI): 30.5–44.7%), but from 14 years, this probability increased to 74.4% (95% CI: 69.3–79.3%). The dataset lacks data for the period 10–13 years inclusive, meaning that the mean plant age at which probability of bearing cones transitions from low to high cannot be resolved more closely.

Juvenile plants (younger than 10 years) had an expected 0.5 (95% CI: 0.4–0.6) cones per plant, while for mature plants (older than 13 years) this increased to 1.5 (95% CI: 1.3–1.8). Several years' production of cones made up the total canopy seedbank, which was low in the first decade after fire, and reached a plateau from 15 years post-fire (Figure 2). Trajectories of cone production were not shown from 10 to 13 years' post-fire due to the lack of data for this period.

An average of 8.0 (SE 0.8) seedlings per dead adult Hairpin Banksia was recorded six months after autumn fuel reduction burns. However, only 0.8 (SE 0.3) seedlings

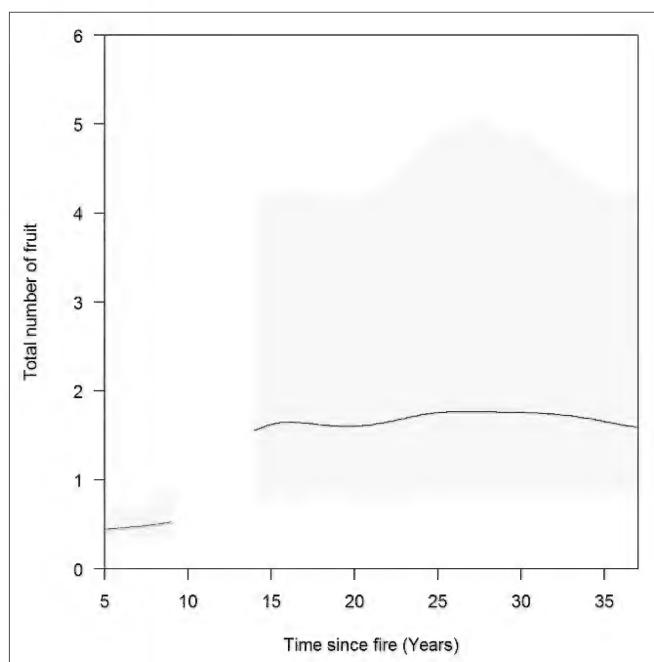


Figure 2. Total number of cones per plant (unconditional) as a function of time since fire. Curve shows the median and the shaded area represents 95% credible interval. Trajectories of cone production are not shown from 10 to 13 years post-fire due to the absence of data for this period.

per adult on average was recorded at 1.5 to 2 years post-fire. This apparent reduction may be due to increased seedling mortality from summer drought stress or browsing.

Proportion of species distribution impacted by fire

Of the 266 recorded occurrences of Hairpin Banksia in East Gippsland, 78% were mapped as burnt (at any severity) within the boundary of the 2019–2020 bushfires. For the area of the species distribution model in the East Gippsland region, 88% was within the 2019–2020 fire boundary and 29% had experienced fire in the prior 10 years (Figure 3). The percentage habitat burnt in the last 10 years is overestimated due to lack of fine-scale mapping for some planned burns, but is likely to be a significant proportion of the East Gippsland population.

Conclusions

Our study indicates that seed production in Hairpin Banksia under ten years of age is likely to be insufficient for replacement recruitment. A precautionary interpretation is that two fires in 10 years would cause a severe decline in the local persistence of Hairpin Banksia. Rainfall in the three years preceding the 2019–2020 bushfires was well below average in the study area in East Gippsland (BOM 2020), and seed production may have been lower than measured in our study.

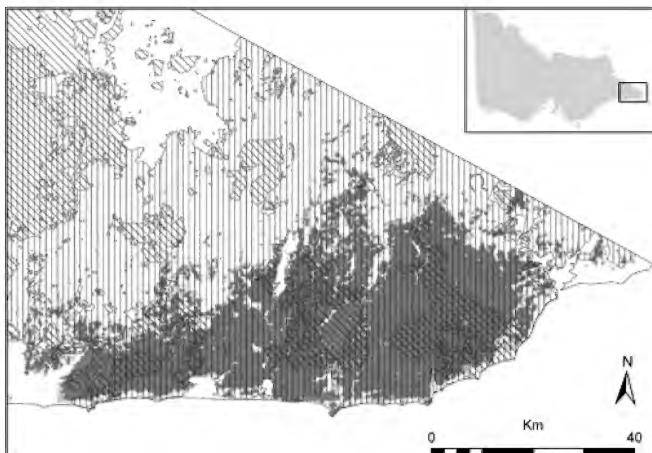


Figure 3. Distribution of Hairpin Banksia and recent fires in Victoria. Modelled habitat is shown in green; 2019–20 bushfires in vertical hatching; fires 2009–2019 in diagonal hatching.

The spatial data suggest declines in populations of Hairpin Banksia across up to 30% of the species' range in East Gippsland, with additional declines likely over the next decade as fires reoccur in this area. Ground verification in Spring 2020 will confirm the extent of adult plant death, and levels of seedling recruitment. It is unknown what effects post-fire grazing by feral deer may have on emerging seedlings.

What actions can be taken to address these risks to Hairpin Banksia? Field surveys are needed to determine the extent of decline within the fire ground where previous fire occurred in the last 10 years.

As an insurance strategy, seed should be collected from different populations of Hairpin Banksia to preserve genetic diversity across its range. Management and research attention are needed for relatively widespread species such as Hairpin Banksia, which are susceptible to reductions in population size and distributional extent caused by increased fire and climatic warming.

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Acknowledgements

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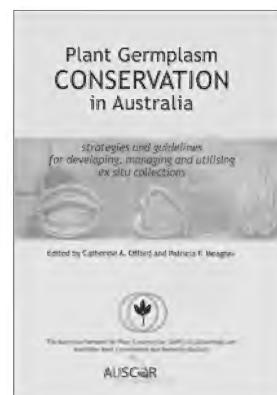
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Serious impacts of longwall coalmining on endangered Newnes Plateau Shrub Swamps, exposed by the December 2019 bushfires

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Situated in the highest part of the Blue Mountains of NSW the characteristic Newnes Plateau Shrub Swamps (NPSS) provide habitat for a suite of threatened flora and fauna. In 2005, subject to a range of threatening processes, these swamps were listed as an Endangered Ecological Community (NSW BC Act 2016), and subsequently as part of the Commonwealth Temperate Highland Peat Swamps on Sandstone Endangered Ecological Community (EPBC Act 1999).

Impacts of longwall mining

The Newnes Plateau is underlain by significant coal reserves, and nearby Lithgow has a long history of traditional bord and pillar coalmining. However, current underground coal extraction of concern involves longwall mining, with more complete removal of coal and increased subsidence impacts than older methods. In spite of denials from the coal industry, there has been increasing evidence of the lowering and loss of water tables in undermined NPSS swamps, and resulting impacts on groundwater-dependent flora and fauna. NPSS are groundwater dependent ecosystems, with differing proportions of dependence on precipitation and groundwater (Benson and Baird 2012). ‘Alteration of habitat following subsidence due to longwall mining’ has been listed as a Key Threatening Process in NSW (NSWSC 2005) in recognition of the potential impact of subsidence on the quality and/or quantity of groundwater available to groundwater-dependent ecosystems.

Our observations in NPSS swamps have confirmed the continuing presence of surface moisture along drainage lines through these swamps, and maintenance of at least some continuous stream flows in their effluent streams, throughout the Millennial drought (1997–2009) (IRCB, PhD research and unpubl. obs.; DHB, in fieldwork, environmental inquiries e.g., Birds Rock Colliery 1981) (Figures 1a–e). Since 2012, when we described the natural vegetation of the swamps (Benson and Baird 2012), and including the recent 2019 drought period, we have continued to record conditions in both undermined and non-undermined reference swamps, through fieldwork records and photographs.

We have seen increasing drying out of vegetation in undermined swamps (Junction Swamp undermined 2003–2004; East Wolgan Swamp, 2006; Carne West Swamp, 2013–2014; Gang Gang West Swamp, 2015–2016; Gang Gang East Swamp, 2017–2018) and increasing evidence of lowering water tables (see Figure 2 for Carne West). Peaty swamp soils have dried and oxidized, seepages disappeared, and the central drainage lines and streams ceased to flow. This has been accompanied by desiccation and, depending on species, gradual death of plants (Figure 1f). In stark contrast, reference swamps (e.g., Broad Swamp, Sunnyside Swamp) which lie outside the mining impacted area, have maintained consistent seepage areas and high soil moisture, with no obvious visual evidence of lasting drought effects on vegetation, despite periods of severe drought (Figures 1a–c).

Impacts of fire

The recent December 2019 bushfire swept across the Newnes Plateau burning most of the swamps, including previously undermined, and reference swamps, followed by good rain in February–March. Vegetation recovery in the reference swamps has been rapid with vigorous resprouting of shrubs and sedges, and little evidence of death of plants despite the severity of the fire. There has been relatively little combustion of surface peat (Figures 3a–c).

In contrast, the impact of the fire in undermined swamps has been catastrophic (Figs 3d–f). There have been large areas where all lignotuberous resprouter shrubs have been killed or completely combusted, including those with very large and presumably old lignotubers, such as *Leptospermum* and *Baeckea* species (Figure 3e). Similarly, large tussock-forming and apparently long-lived foundational sedgeland species such as Buttongrass, *Gymnoschoenus sphaerocephalus*, *Xyris ustulata* and *Empodisma minus*, have been either killed, or are barely surviving. With the destruction of the dried out surface peat, the rooting zone bases of very large old tussocks, which typically survive fire in moist peat conditions, have been substantially burnt away (Figure 3f).



Figure 1 (a) Broad Swamp, a large wet peat swamp, with *Boronia deanei*, *Grevillea acanthifolia*, *Pultenea divaricata* and *Sprengelia incarnata* in flower. This swamp maintained surface seepage throughout the Millennial drought. Photo: Ian Baird, 9 September 2010; (b) Broad Swamp with seepage-fed streamlet and flowering shrubs. Core habitat for *Eulamprus leuraensis* and *Petalura gigantea*. Photo: Ian Baird, 9 September 2010; (c) Broad Swamp with *Euastacus australasiensis* burrow complex in saturated peaty substrate with high water table; high quality reproductive microhabitat for *Petalura gigantea* and core habitat for *Eulamprus leuraensis*. Photo: Ian Baird, 1 November 2008; (d) Carne West Swamp showing wet peat swamp with dense sedgeland and shrub vegetation near the end of the Millennial drought. Photo: Ian Baird, 18 January 2007; (e) Carne West Swamp showing wet swamp vegetation with peaty soil and seepage-fed streamlet at the end of the Millennial drought. Some drought-affected Coral-fern, *Gleichenia dicarpa*, evident. Core habitat for *Eulamprus leuraensis* and *Petalura gigantea*. Photo: Ian Baird, 12 January 2008; (f) Carne West Swamp after undermining, showing extensive dying vegetation along previously wet but now dry, main drainage line. Photo: Ian Baird, 6 December 2016

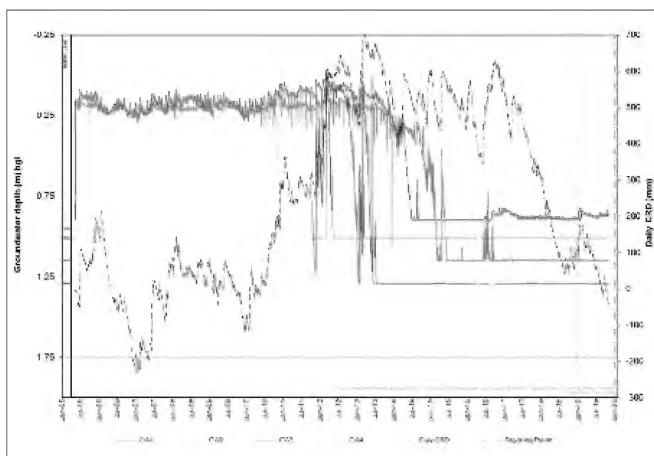


Figure 2. Carne West Swamp piezometer hydrograph for piezometers CW1 (red), CW2 (green), CW3 (mauve), and CW4 (pale blue) from 2005 to 2020 (Centennial Coal 2020). Following undermining, the water level in all piezometers had dropped dramatically by July 2015 to at or near the bottom of piezometers and has not recovered, regardless of prevailing rainfall.

The soil surface in undermined swamps, already unnaturally dry before the burn, has been dramatically altered as a result of ongoing oxidization and then combustion of the peaty-organic surface layer, often to a depth of 10–30 cm, exposing the roots of old tussocks, and roots and lignotubers of shrubs (Figure 3e). It is likely that the soil seedbank has also been largely destroyed and large areas effectively sterilized (Figure 3d–f). In any case, swamp species are unlikely to recruit without suitable moist conditions. This includes the vulnerable *Boronia deanei* subsp. *deanei* and endangered *Carex klaphakei*. In contrast to the extensive seedling recruitment and resprouting in reference swamps, undermined swamps are characterised by an absence of both, with the exception of some recruiting non-swamp *Eucalyptus* and *Acacia* seedlings. These observations are consistent with our predictions of a transition from groundwater dependent mires to rainfall dependent non-mire vegetation communities (swamp or non-swamp), following mining-related loss of groundwater.

In addition to the mire ecosystems themselves, associated groundwater dependent fauna, including the endangered Giant Dragonfly, *Petalura gigantea*, and endangered Blue Mountains Water Skink, *Eulamprus leuraensis*, are threatened by the potential compounding effects of lowering water tables, more intense fire regimes, and projected climate change (Baird and Burgin 2016). Monitoring of *Petalura* populations in the undermined swamps, and observations of the loss of all suitable ovipositing and larval burrowing habitat, suggests that they have been extirpated as a result of the loss of groundwater (IRCB, unpubl. data).

Monitoring of *Eulamprus* populations in recently undermined swamps has indicated reduced abundance and a dramatic loss of suitable habitat (S. Gorissen, unpubl. data). The loss of core habitat in individual swamps is likely to lead to the extirpation of these populations.

Based upon observations of the loss of the necessary hydrological conditions and absence of burrows in undermined swamps, the groundwater-dependent, burrowing Sydney Crayfish, *Euastacus australasiensis*, a

swamp ecosystem engineer whose burrows are also used by *Eulamprus* (Baird and Burgin 2016; Benson and Baird 2012), appear to have now been eliminated from these swamps. Populations of Swamp Rat, *Rattus lutreolus*, an under-appreciated ecosystem engineer in these swamps can be expected to have been severely impacted at the very least and unlikely to recover to previous abundance, if at all.

Our observations of the impact of the longwall mining-related lowering of watertables and subsequent fire impacts in these swamps provides dramatic evidence of the irreversible damaging impacts of longwall mining. Unlike the reference swamps, the undermined swamps failed to respond to good rains since January 2020, with almost no resprouting of typical and often long-lived, resprouter sedgeland and shrub species, destroying any hope that future rainfall might allow some semblance of the pre-mining conditions to return. These groundwater-dependent peat swamps are scarce and already face a rapidly changing climate; the dead swamps provide clear evidence of the impacts of longwall mining. No more swamps should be allowed to be destroyed.

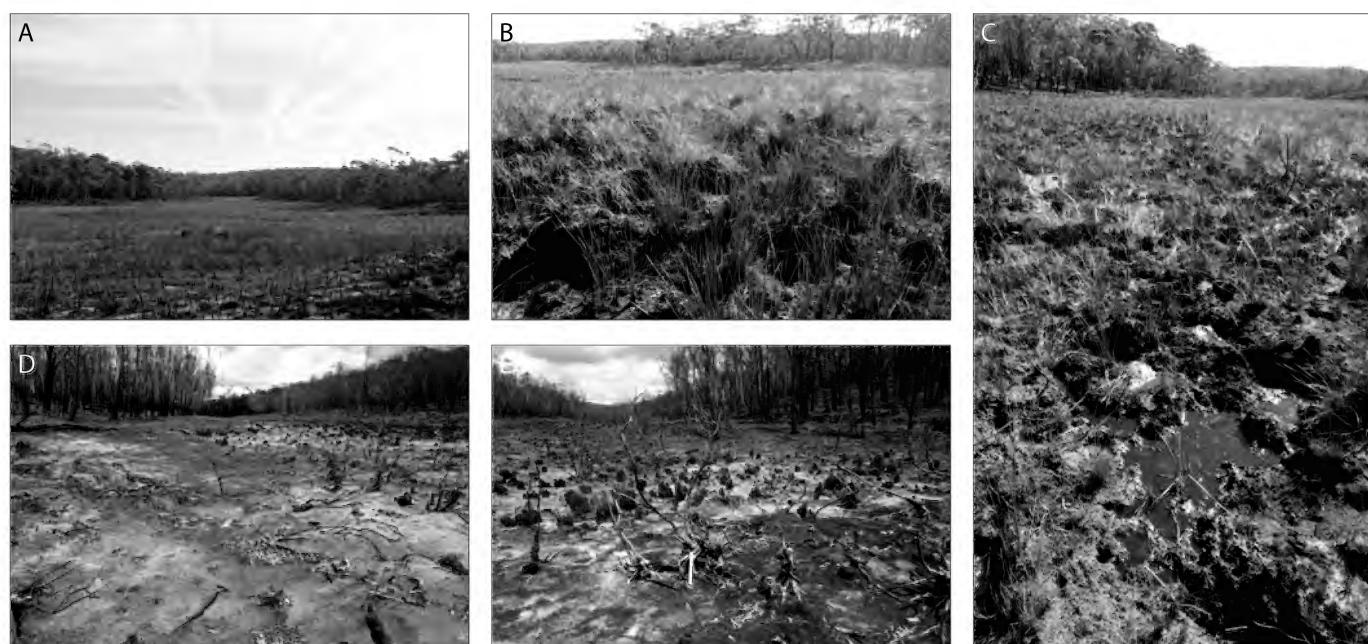


Figure 3 (a) Broad Swamp after December 2019 fire, showing rapid resprouting of swamp sedgeland because of high water table and minimal combustion of peaty soil and vegetation tussocks. Photo: Ian Baird, 19 March 2020; (b) Broad Swamp after December 2019 fire, showing vigorous sedgeland resprouting and complex hummock-hollow microtopography of fibrous peat. Hollows frequently have seepage pools. Photo: Ian Baird, 19 March 2020; (c) Broad Swamp after December 2019 fire, showing emergent groundwater along seepage line and complex microtopography of fibrous peat, with abundant burrows of groundwater-dependent *Euastacus australasiensis* and *Petalura gigantea*, with pre-fire foraging excavations of *Rattus lutreolus*. Photo: Ian Baird, 19 March 2020; (d) Carne West Swamp showing December 2019 fire impact, with deeply burnt and simplified microtopography in what was a wet peat swamp with perennial seepage lines, complex microtopography and suitable habitat for *Petalura gigantea* and *Eulamprus leuraensis* pre-undermining. Photo: Ian Baird, 11 March 2020; (e) Carne West Swamp after December 2019 fire, showing deeply burnt peaty substrate, burnt and frequently dead tussock bases of *Gymnoschoenus sphaerocephalus* and *Xyris ustulata*, and exposed fire-killed shrub lignotubers (Scale rule 30 cm). Photo: Ian Baird, 11 March 2020; (f) Carne West Swamp after December 2019 fire, showing burnt tussock base and exposed root zone of old *Gymnoschoenus sphaerocephalus* tussock (Scale rule 30 cm). Photo: Ian Baird, 11 March 2020

Acknowledgements

Our research colleagues, Martin Krogh and Sarsha Gorissen, are thanked for their ongoing commitment to better understanding and protecting these swamp ecosystems.

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Late summer and autumn rains spark new hope for three Endangered Midge Orchids in South-east NSW

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Background

Midge Orchids (genus *Genoplesium*) are a group of small terrestrial orchids typically producing a short, single flowering stem between 10–30 cm high, bearing clusters of small flowers in a moderately dense spike. When not in flower, only a single, thin, green leaf is present above ground that is indistinguishable from other midge orchids.

In recent times, officers from the Department of Planning and Environment (DPIE) Ecosystems and Threatened Species team with NSW National Parks and Wildlife Service (NPWS), have become increasingly concerned about the low numbers of individuals of three threatened midge orchids being monitored as part of the NSW *Saving our Species* (SoS) program. Declines in populations appear related to unfavourable weather conditions associated with reduced summer rainfall, with uncertainty as to whether populations could ultimately survive under prolonged drought. Late summer and autumn rains in south-east NSW have contributed to a relatively large increase in the flowering populations of these orchids, bringing renewed hope that they will persist for a little longer. The stories of these midge orchids are outlined in this article.

Rhyolite Midge Orchid (*Genoplesium rhyoliticum*)

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The Rhyolite Midge Orchid (*Genoplesium rhyoliticum*; Figure 1) is Endangered in NSW (*Biodiversity Conservation Act 2016*) and nationally (*Environment Protection and Biodiversity Conservation Act 1999*) and nationally. Its habitat is extremely specific, with only a handful of records from seven rhyolite outcrops in the far south-east of NSW. In 2002, the estimated total population was around 1,300 (NPWS, 2002); however, more recent counts suggest the species has declined by approximately 85% in the past 20 years.

The tiny plants grow in shallow crevices on rhyolite rock outcrops, in a thin layer of soil usually dominated by mosses and lichens. These refugia also support a diversity of invertebrates which attract fauna such as lyrebirds who turn over the moss to forage for insects. Such disturbance of the moss-beds may expose the tubers to desiccation and predation, and with so few plants occupying these moss-beds protecting them from disturbance to facilitate flowering and seed set is considered a management priority. In addition to protecting the immediate areas where the plants grow, staff from DPIE and NPWS have been monitoring the known sites under the SoS program to better understand the distribution and trajectory, but numbers have been nowhere near the 1,300 plants

reported to exist with only 31 flowering plants observed over two outcrops in 2019.

Although the flowering period is recorded as December to January, flowering of *G. rhyoliticum* appears to be largely triggered by rainfall. In January 2020, following an incredibly dry few months, the Border Fire in southern NSW spread northwards to within one kilometre of the known sites, so monitoring could not be safely undertaken until mid-February. It was therefore assumed the flowering window had been missed. However, a fortuitously timed rain event in early February triggered a late flowering response and we were delighted to discover 50 flowering plants on five outcrops.



Figure 1. Rhyolite Midge Orchid. Photo: Jackie Miles, DPIE

The strategy

Due to the variability of flowering and remote nature of these rhyolite outcrops, past surveys have been opportunistic and resource dependent. Since the introduction of SoS, annual population counts have been conducted at two important outcrops and other sites have been monitored. Other critical actions include habitat protection from native herbivores and monitoring for emerging threats.

Wildlife cameras were installed at one site to determine the cause of disturbance at an important moss-bed (Figure 2). In order to protect the few plants thought to remain, stainless steel mesh panels were installed over small areas to help the moss recover from lyrebird diggings and protect it from further disturbance.



Figure 2: Wildlife camera image showing moss-bed with a lyrebird fossicking for insects.

Extensive surveys were initiated this year (2020) after one population was observed to be flowering in higher numbers than recent years. Nine outcrops were surveyed in late February and March including five where the species had previously been recorded.

All plants (including leaves) were counted. Although the identity of sterile plants cannot be 100% confirmed, these are very likely to be *G. rhyoliticum* based on leaf characteristics and that no other *Genoplesium* species have been recorded in the area with which it could be confused.

Results

Wildlife camera footage showed that mesh was successful in deterring lyrebirds and herbivores from overturning the moss. This was confirmed during February's site visit when panels were observed to be intact with non-browsed plants persisting (Figure 3). Some of these plants flowered and set seed, which were collected and sent to the Australian PlantBank at the Australian Botanic Garden Mount Annan.

Table 1 shows the monitoring results from the past four years. From 2017–2019, below average rainfall resulted in poor emergence of the species and a reduced survey effort, as the plants would have likely been dormant if present. In 2020 all five locations with previously known records had plants – the other two outcrops were not surveyed, although it is probable that they also supported good numbers. Four outcrops not previously surveyed did not have any plants.

Table 1. Monitoring results of the Rhyolite Midge Orchid from the past four years.

Year	Flowering	Non-Flowering
2016–2017	0	11
2017–2018	0	33
2018–2019	31	17
2019–2020	50	142



Figure 3: Rhyolite Midge Orchid leaves with habitat protection.

Photo: Laura Canackle, DPIE

It is not clear whether the 1,300 plants reported in 2002 included non-flowering plants so it is difficult to compare 2020 numbers with confidence, but it is certain there has been a sharp decline over the past two decades. Numbers are still critically low, which leaves the species vulnerable to localised stochastic events. Fortunately, these plants escaped the fires over summer 2019–2020 so they were able to flower this season.

The reason for the higher emergence and flowering in 2020 may not only be due to the February rain event but also that the extremely dry season leading up to the flowering period resulted in some shrub death, leading to more habitat availability on the outcrops (Jackie Miles, 2020 pers comm.). It is hoped the coming year brings more reliable rainfall, and that some outcrops may still have undiscovered populations persisting, waiting to be discovered and conserved through continued investment in threat mitigation.

Superb Midge Orchid (*Genoplesium superbum*)

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The Superb Midge Orchid (*Genoplesium superbum*; Figure 4) is Endangered in NSW (*Biodiversity Conservation Act 2016*), with a few small populations in the Nerriga and Mongarlowe area and a disjunct record around Lithgow. The habitat is non-specific, with occurrences on rock shelves, dry forest and grassy woodlands on Ordovician and Permian sediments. Flowering generally occurs from December to April in response to substantial summer and autumn rains, as have occurred in 2020.

With varied habitat and small population sizes, main threats include land development and a range of threats associated with small and isolated populations including inbreeding depression and increased susceptibility to stochastic events (DPIE, 2020). Opportunistic browsing by native herbivores is a threat at each population, along with unpredictable warm-season rainfall.

Some populations were burnt by the Currowan and Gospers Mountain fires in early 2020, whereas others escaped the fire by small margins. The late summer and autumn rain sparked a significant flowering event after recent years yielded minimal or no flowering in all populations.



Figure 4. Superb Midge Orchid, showing characteristic coarse, pinkish mauve cilia and purplish lateral sepals.
Photo: Rob Armstrong, DPIE

The strategy

Under the SoS program, we have been undertaking critical actions to reduce the threat to populations such as caging individuals to reduce opportunistic browsing, installing roadside markers in collaboration with local councils, weed control and increasing survey effort in better years to determine the extent of current populations and find new populations.

Targeted surveys in known locations were undertaken to confirm above-ground presence, with meandering surveys in nearby suitable habitat. Where presence was confirmed at key sites, each plant was tagged and demographic parameters suggested by Swarts and Dixon (2017) including flowering status, number of flowers on each plant, grazing pressure, microhabitat, leaf length, inflorescence length, total length and seedpod development were measured. Covariate information on fire intensity and preceding rainfall events was also noted (BoM, 2020). Populations were periodically monitored to check seedpod development and the emergence of additional plants.

Results

After no records in early 2017 and 2018, minimal records in 2019 (no plants in Mongarlowe cluster and four in Nerriga cluster), the significant and well-timed January–February rainfall event sparked a flowering/emergence event not seen since the inception of the SoS surveys in early 2017. In burnt areas, it is likely that smaller plants were more detectable. Table 2 shows the number of orchids observed across years, with rainfall for January–February since 2017 compared to the long-term median; in 2020 there was 2-day rainfall events of 145.4mm at Nerriga (250% of median February rainfall) and 109.2 mm at Mongarlowe (191% of median February rainfall), a phenomenon not seen in previous years, that contributed to the eventual suppression of the Currowan fire after 74 days. It is considered that this soaking rain lead to the significant flowering.

The large number of plants provided the first opportunity to examine population demographics. There were no obvious trends between sites/clusters or burnt/unburnt populations, however recorded information suggests there is significant variation beyond that of the described taxon.

Seed pod development was noted across all plants that had flowered (Figure 5), although with flowering observed from early March to late April, observations were not made on the late-flowering plants. However, it appears that pollination rates are very high which was pleasantly surprising as the level of impact on pollinators in fire-ravaged areas was unknown. Most *Genoplesium* are pollinated by very small Diptera (Kuiter, 2016); it is unknown if the Superb Midge Orchid is autogamous and many smaller *Genoplesium* previously thought as such are now suspected to be pollinated in part by very small Diptera (Scatopsidae), so it is considered likely that pollinators are present. Seeds were collected from five locations within the Nerriga and Mongarlowe clusters, as well as the disjunct population near Lithgow.

Not surprisingly, browsing rates on uncaged plants differed markedly between burnt and unburnt populations, with a browsing rate of 53% in unburnt areas (30 samples) and 6% in burnt areas (34 samples). The browsing rate in unburnt samples is consistent with observations in other *Genoplesium* (e.g., *G. littorale*, observed browsing rate of 50%; Bower et al. 2015). Low browsing rates in burnt areas are reflective of the catastrophic effect of the 2019–2020 fire season on browsing fauna.



Figure 5. Caged Superb Midge Orchid, with developing seedpod. Photo: Rob Armstrong, DPIE

Table 2. Orchid detection relative to January–February summer median rainfall.

Year	Nerriga Cluster			Mongarlowe Cluster	
	Plants	Rainfall mm (% of Jan-Feb median)		Plants	Rainfall
2017	0	74.8mm (65%)		0	53.2mm (47%)
2018	0	153.8mm (134%)		0	134mm (118%)
2019	4	99.6mm (87%)		0	165.2mm (146%)
2020	137	249.8mm (217%)		40*	185.6mm (164%)

* includes a new population of 13 plants.

Tallong Midge Orchid (*Genoplesium plumosum*)

The Tallong Midge Orchid (*Genoplesium plumosum*; Figure 6) is Critically Endangered in NSW (*Biodiversity Conservation Act 2016*) and Endangered nationally (*Environment Protection and Biodiversity Conservation Act 1999*). Until recently it was only known from the vicinity of Tallong with very small disjunct populations near Marulan and Wingello. The habitat is highly specific, with the species only growing on sandstone rock shelves that support low heath, mosses and lichens. Flowering occurs between mid-February and late-April, with flowering generally occurring 3–4 weeks after substantial summer or autumn rainfall.

The largest population occurs near Tallong, with many sub-populations occurring on residential blocks and road verges. Most sub-populations have been under threat by construction, vehicle movements, soil dumping or weed invasion. Fortunately, some sub-populations occur on land that has been set aside to protect the orchid. Other threats include those associated with small and isolated populations, particularly increased susceptibility to stochastic events such as drought. Browsing by native herbivores, particularly wombats, is also a threat leading to reduced seed production needed for ongoing recruitment. The Tallong and Marulan populations were also spared from the recent bushfires.

A recovery plan completed in 2002 facilitated detailed surveys of known and potential habitat, establishing three permanent monitoring plots on protected land at Tallong to track population trends and monitor individual plant demography. All flowering plants were measured and tagged initially, and along with subsequent new plants, measured and tagged annually.



Figure 6. Tallong Midge Orchid, best distinguished from several co-occurring midge orchids by its elongated dark purplish labellum with its short fringe of dark hairs at its tip. Photo: John Briggs, DPIE

The strategy

Selected recovery actions from the recovery plan were incorporated into the SoS conservation project, with two new actions added to help address the apparent long-term decline. These include seed collection and storage in the Australian PlantBank and undertaking research into propagation, which if successful, would provide translocation options.

Results

Tallong Midge Orchid has 20 years of annual monitoring data from three plots established in 2001 (prior to the onset of the millennium drought), documenting the impact of that drought and release in 2010, as well as the initial response to recent rains providing some relief in the current drought.

Figure 7 shows the number of flowering plants within plots from 2001 to present. The impact of the millennium drought is clearly evident, with a steady decline in flowering plants from 2001 (96 plants) to 2006 (5 plants), with the number remaining below 15 until the breaking of the drought in 2010 (40 plants; less than half pre-drought numbers). Numbers of flowering plants have been below 30 in all subsequent years. Despite the observed strong flowering of other midge orchids in 2020, the number of flowering plants in the Tallong Midge Orchid plots has not shown a marked increase. Given the current conditions, it would seem reasonable to expect an increase to numbers similar to 2001 if the long-term situation was relatively stable. The decline suggests a long-term lag from the effects of the millennium drought and subsequent conditions.

Fortunately, the situation for Tallong Midge Orchid may not be as dire as plot data suggests. Surveys of all sub-populations in the Tallong area in 2020 indicated that the response to recent rains is dependent on aspect, with sites having a northerly and westerly aspect responding poorly relative to less exposed aspects. This is supported by the standardised plot data from the main Tallong population, which shows a general trend of higher relative proportion of flowering in sheltered aspects as drought is prolonged or prevailing conditions extremely dry. For one site there has been an overall increase of flowering plants from 66 in 2019 to 303 in 2020, which is a similar number recorded in 2000. Two plots have a westerly aspect and one has a southerly aspect. In autumn 2020, the west-facing plots had no flowering plants whilst the south-facing plot had nine. The plot placement appears unrepresentative of the overall response due to the susceptibility to drought of west-facing sites. The effect of aspect on flowering can be seen by comparing the relative abundance of flowering on the plot with a southerly aspect with the total number.

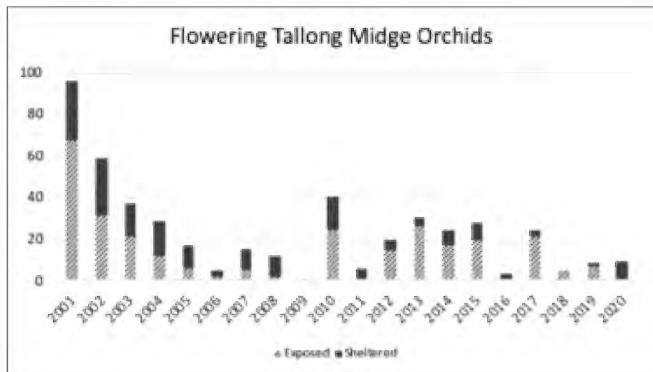


Figure 7. Number of flowering Tallong Midge Orchid plants on monitoring plots each year since 2001.

On another positive note, a re-survey of a previously recorded site near Marulan found a total of 176 flowering Tallong Midge Orchids, up from three a few years ago. This site has an easterly aspect and supports the consistently better response to recent rains recorded on similar aspects. A new smaller population was confirmed while surveying for the Superb Midge Orchid in Morton National Park in autumn 2020 in an area burnt in the recent Currowan bushfire; this represents a 40 km range extension.

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A new project investigating the floral phenology and seed biology of threatened ecological communities in northwest NSW

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Background

Most of the Brigalow Belt South bioregion (BBS) occurs in southern Queensland (QLD), but around one-fifth (19.6%) extends into the North West Slopes region of New South Wales (NSW). In NSW, the bioregion extends south to Dubbo and includes other major towns such as Coonabarabran, Narrabri and Moree. The region experiences hot summers and cool to mild winters with mean annual temperatures ranging from 10° C to 19° C and a highly variable annual rainfall from 449 mm to 1015 mm (Benson *et al.* 2010). The region boasts a diversity of vegetation communities that reflect the contrasting areas of sandstone-derived soils and rich basalt soils. However, many of these communities are now but a small fraction of their historical extent as at least 60% of the BBS and its adjacent bioregions in NSW have been cleared for grazing and cropping (Benson *et al.* 2010). Consequently, there are several Threatened Ecological Communities (TECs), listed under the *NSW Biodiversity Conservation Act 2016*, within the region, including both woodland and dry rainforest ecosystems.

While some research has been conducted on TECs within the BBS, many knowledge gaps remain. In particular, there is a lack of understanding regarding how flowering, fruiting and recruitment potential of key indicator species within these TECs interact with climate factors. This information is critical for developing future management strategies and prioritising restoration efforts for TECs.

In 2019, we commenced a new conservation project to conduct floral monitoring, seed research and community engagement for three TECs in northwest NSW: Brigalow, Semi-evergreen Vine Thicket and Ooline (*Cadellia pentastylis*) community. In this article, we provide a brief overview of each focal TEC before outlining the main project components that will occur over the next 4–5 years. It is hoped that the outcomes of this project will provide critical information to conservation managers and restoration groups to more efficiently maintain and/or restore these unique plant communities.

Threatened ecological communities

Ecological communities are a collection of populations associated by their plant or animal compositions, defined by either spatial boundaries, or by the interactions among populations (Menninger and Palmer 2006). In this project, we are focussing on three separate ecological communities that are under threat from various processes (Table 1).

TEC 1: Brigalow

Brigalow occurs within the 500–750 mm annual rainfall belt, from central QLD down to northern and western NSW. In NSW, it occurs on undulating plains or sandplains on soils with a deep cracking clay texture that can have a high salt content. Brigalow is characterised by open woodland forest with a canopy dominated or co-dominated by *Acacia harpophylla* and a high shrub diversity, but despite a highly fertile soil profile there is a sparse ground layer with little grazing potential (Dwyer *et al.* 2009). Other key canopy species in Brigalow include *Eucalyptus populnea*, *E. pillaensis* and *Casuarina cristata* (Figure 1), and the community also shares numerous species that are also associated with Semi-evergreen Vine Thicket (Department of the Environment 2013).



Figure 1. Photograph of Brigalow community in Brigalow State Conservation Area, NSW. The canopy species in the photo is *Acacia harpophylla* (Brigalow) with its silvery foliage. There is a sparse shrub and ground layer that is typical of the community. Photo: Nathan Emery

Much of the Brigalow woodland has been cleared in preference of grazing and cropping. Approximately 90% of the originally estimated 7.3 million ha extent has been cleared (Department of the Environment 2013). Around 143,000 ha of Brigalow remains in NSW, with many remnants occurring in isolated patches or linear fragments along roadsides.

TEC 2: Semi-evergreen Vine Thicket

Semi-evergreen Vine Thicket (SeVT) is a dry seasonal subtropical rainforest characterised by trees with microphyll-sized leaves (2.5–7.5 cm in length) that are evergreen, semi-evergreen or deciduous (McDonald 2010). Several species are also facultatively deciduous in that much of their foliage is shed during extended dry periods. SeVT occurs in a similar distribution and climate as Brigalow, although this dry rainforest community is associated with different land types and soil types. In NSW, SeVT mostly occurs on hills and hilltops with deep loamy basaltic or sandy loam soils with a medium to high nutrient content (McDonald 2010). The pre-European extent of SeVT is estimated to have exceeded 880,000 hectares, and like the Brigalow woodland, much of the SeVT vegetation has been cleared, with less than 8,000 hectares predicted to remain (McDonald 2010).

SeVT in NSW is dominated by *Notelaea microcarpa*, *Geijera parviflora* and *Ehretia membranifolia*, with floristically rich shrubs and vines and a sparse ground cover. Other common species include *Alphitonia excelsa*, *Casuarina cristata*, *Callitris glaucocephala* and *Capparis mitchellii*, as well as characteristic vines such as *Pandorea pandorana*, *Parsonia* spp. and *Jasminum lineare* (Figure 2; McDonald 2010).

TEC 3: *Cadellia pentastylis* (Ooline) community

Although more common in central and southern QLD, *Cadellia pentastylis* (Ooline) is restricted in NSW to the North West Slopes region. The community



Figure 2. Photograph of Semi-evergreen Vine Thicket community in Mount Kaputar National Park, NSW with *Notelaea microcarpa*, *Beyeria viscosa* and *Dodoneae viscosa* as the dominant trees and shrubs. Photo: Nathan Emery

occurs on undulating terrain with a range of soil types (NSW Scientific Committee 2011). The dry rainforest vegetation is described by Curran *et al.* (2008) as 'Cadellia pentastylis low microphyll vine forest', with the following as key associated species: *Eucalyptus albens*, *Callitris glaucocephala*, *Elaeodendron australe*, *Geijera parviflora*, *Notelaea microcarpa*, *Beyeria viscosa*, *Carissa spinarum*, and *Teucrium junceum* (Benson 1993; Curran *et al.* 2008; Figure 3). Species compositions among stands of Ooline are variable with those occurring on claystone soils having a higher herbaceous diversity than those on sandstone or conglomerate substrates. At least half of the pre-European population of Ooline (around 2,500 ha) has since been cleared for logging or agriculture, and remnant stands are highly fragmented and are susceptible to grazing and fire (Benson 1993; NSW Scientific Committee 2011). As of 2010, it was estimated around 1,000 hectares remained with 10% occurring in protected areas (Benson *et al.* 2010).

Table 1. A summary of the threatening processes affecting each of the three focal TECs as listed in the NSW *Saving our Species* database. More details can be found at www.environment.nsw.gov.au.

Threatening process	Brigalow	Semi-evergreen Vine Thicket	Ooline (<i>Cadellia pentastylis</i>)
Land clearing and fragmentation	✓	✓	✓
Invasion from weed species	✓	✓	✓
Overgrazing by domestic stock	✓	✓	✓
Lack of value and understanding by landholders and managers	✓	✓	✓
Predation of wildlife by foxes and feral cats	✓	✓	
Wildfire and hazard reduction burns		✓	✓
Climate change		✓	✓
Lack of pollinators	✓		
Spray drift of herbicides/pesticides	✓		
Lack of viability of seed set	✓		
Logging	✓		
Changes in hydrology by pumping groundwater	✓		
Erosion of soils			✓



Figure 3. Photo of an Ooline (*Cadellia pentastylis*) community in Gamilarioi Nature Reserve, NSW featuring a prominent *C. pentastylis* tree in the centre and regrowth on the left, and a *Carissa spinarum* shrub to the right. Photo: Philippa Alvarez

Project components

Monitoring

We recently commenced a long-term monitoring protocol for each TEC using permanent plots (Figure 4). Within each community, we have set up three sites, each with four, 10 x 10 m plots. By surveying these plots, we are measuring species diversity, structure and phenology through time, with a focus on how these values respond to seasonal fluctuations and rainfall events. We aim to determine whether key indicator species in our focal TECs are risk-takers (*i.e.*, produce flowers and set fruits during dry periods) or risk-avoiders (*i.e.*, only produce flowers and set fruits in response to rainfall and/or specific temperatures).

After our first monitoring trip, we have calculated the Shannon-Weiner diversity index, which considers the species richness and abundance for each site. Diversity was similar for all sites, but slightly higher for Brigalow and SeVT than Ooline sites (Figure 5). This trip was conducted during a period of extended drought, and the communities were showing signs of severe stress and dieback (Figure 6). We therefore expect these values will change over time, especially in response to the significant rainfall events in February and March 2020.

Seed conservation

Another key aspect of this project is the collection of seeds for research and conservation. Understanding a

species' seed biology is a key step towards restoring and conserving of ecological communities globally. Not only does this information give insight into natural recruitment within these systems which can aid in management, it allows for more cost-effective restoration efforts through direct seeding (Palma and Laurance 2015). Furthermore, by learning germination protocols for the key species from the TECs, propagation protocols can be developed, bolstering the *ex situ* conservation tools available for each species to enable plants to be grown in nurseries or to develop seed production areas.

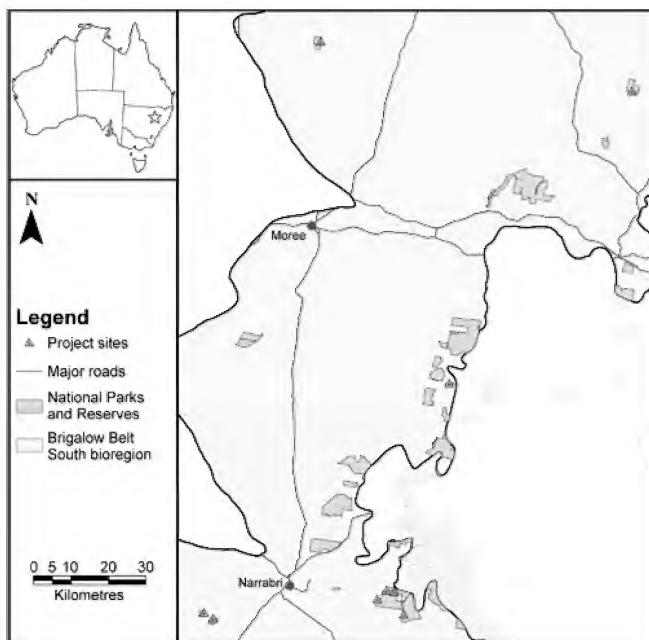


Figure 4. A map of the study area for this project. All sites are within the NSW Brigalow Belt South bioregion.

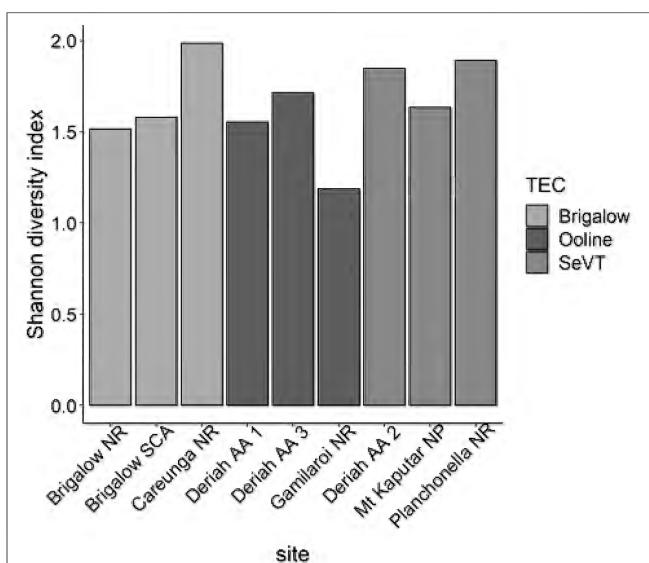


Figure 5. The Shannon-Weiner diversity index for each study site. This index considers the species richness and abundance for each site. The bars for each site are grouped into colours which represent the three Threatened Ecological Communities (Brigalow, Ooline and Semi-evergreen Vine Thicket (SeVT)).



Figure 6. Significant plant dieback and drought stress in Planchonella Nature Reserve, NSW in December 2019.
Photo: Nathan Emery

Seeds will also be collected for long-term storage at the Australian PlantBank, at the Australian Botanic Garden Mount Annan. Storing seeds is another form of *ex situ* conservation that can be used as an ‘insurance policy’ for the species into the future and is a cost-effective conservation measure.

Seed biology research

The storage of seeds can be complicated and varies between species. We will be using artificial seed aging experiments to understand the storage behaviour of our target species, which will facilitate higher quality seed collections being stored in seedbanks.

Seed germination success is often influenced by the type of dormancy. Seed dormancy prevents a seed from germinating when conditions are ‘unfavourable’ and can be relaxed by specific (and sometimes multiple) environmental cues, allowing germination to occur. To test for dormancy type and requirements we will be running preliminary germination trials that identify the conditions and/or treatments required to relax dormancy.

Once the initial germination and dormancy tests are completed, we can scale-up the process using a thermo-gradient plate to examine germination along a bi-directional temperature gradient from 5° C to 35° C. This method helps identify the ‘temperature envelope’ that a species will germinate. This data can then be used to predict germination *in situ* under current climate conditions and modelled future climate scenarios. Finally, we will also examine seed survival and germination capacity under different water potentials from saturation point to permanent wilting point. These data are critical for determining how seeds will respond to extended and more extreme droughts.

Community engagement

One of the key issues highlighted in the ANPC’s recently released Australian Native Seed Survey Report (Hancock *et al.* 2020) was the need for training and education of both seed collectors and purchasers. We aim to address this issue by incorporating a community engagement program later in the project. Once we understand how to best propagate the species within these communities, we will work with the Northern Slopes Landcare Association to run a series of workshops to engage with local and land councils, restoration and regeneration groups, landholders, and others. These technology-transfer events will share information on how to properly collect, store and germinate seeds of numerous species that occur in our focal TECs with the goal of achieving greater conservation and restoration outcomes.

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Sand Spurge: The reintroduction

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The urgent translocation

Sand Spurge (*Euphorbia psammoegeton*) is a perennial prostrate herb that forms mats to 1 m across.

The species grows on coastal sand dunes and other near-shore habitats such as the base of headlands and on beach shelves (Figures 1 and 3). The species is rare and distributed from the Shoalhaven region in

New South Wales (NSW) to south-east Queensland (QLD), usually in small, transient populations that are disjunct from one another. The species occupies the dynamic foredune environment and is frequently impacted by erosion during large coastal storm events. Seeds mature in capsules (Figure 2) that explode, distributing the seeds up to several metres. The seeds are also known to float, meaning that dispersal via sea currents is likely.



Figure 1. Example of mature plant. Photo: Gavin Phillips



Figure 2. Sand Spurge flowers and fruits, Wamberal Lagoon National Park. Photo: Barry Collier



Figure 3. Usual habitat of Sand Spurge. Photo: Gavin Phillips

Sand Spurge is listed as Endangered under the NSW *Biodiversity Conservation Act 2016*. The main threats to the species include competition from weeds, sea level rise and increased frequency of storm surges, and pedestrian and vehicle trampling. As a result, it has a high risk of extinction from stochastic events (e.g. drought) due to small population sizes. Recent regular survey and monitoring has shown significant reductions in the species' area of occupancy and abundance, including three local extinctions.

Under the NSW *Saving our Species* (SoS) program, this species was identified to require site-based management in order to secure it from extinction in NSW for 100 years. There are six key management sites identified as critical to the conservation of the species under this program, in addition to several other known populations that are not part of the SoS conservation project:

1. Jones Point to Freshwater Beach, Yuraygir National Park (NP), Clarence Valley.
2. Serenity Beach, Moonee Beach NR, Coffs Harbour.
3. Blinky Beach, Lord Howe Island.
4. Seven Mile to Yacaaba, Myall Lakes and Booti Booti NPs, Mid North Coast.
5. Wamberal Lagoon Nature Reserve (NR), Central Coast (Figure 2).
6. Warrain Beach, Shoalhaven.

The largest known population of approximately 2,500 individuals occurs from Seven Mile to Yacaaba, while all other populations average from 30 to 100 individuals, but fluctuate greatly.

In response to the observed declines in population numbers, loss of habitat and the suspected extinction of the Shoalhaven population due to storm erosion during the winters of 2017 and 2018, National Parks and Wildlife Service (NPWS) decided that translocation was urgently needed to bolster populations. Several site-specific translocation plans were simultaneously prepared for

the Wamberal Lagoon NR, Shoalhaven, Serenity Beach and Yuraygir NP populations. A separate translocation proposal was also prepared for the Lord Howe Island population. The objective was to augment recently depleted populations or, in the case of the Shoalhaven, Wamberal and Serenity Beach locations, reintroduce the species to where it formerly occurred if it was suspected to be locally extinct. For each site, minimum targets for adult and juvenile Sand Spurge plants were developed, based on knowledge of previous population size, available habitat and capacity to collect, grow and maintain plantings. Minimum target population sizes ranged from 50 to 100 plants. Plans were reviewed by translocation experts and approved with issue of a Scientific Licence.

Seeds were collected from the intended recipient site or the closest population (if extinct or too low in numbers). Plant propagation occurred in a community nursery, and outplanting is being primarily conducted by NPWS staff due to COVID-19 restrictions on volunteer involvement. Around 50% of untreated seeds germinate, and seedlings grow relatively easily in a nursery environment. Earlier attempts to germinate and propagate seed in late autumn and winter 2019 resulted in significant plant mortality in nurseries on the Central and South Coasts, which has been attributed to possible excessive moisture levels and fungal attack. Germination commencing from spring 2019 experienced much lower mortality, likely due to warmer and drier conditions. As plants are often browsed on by rodents, possums and lizards caging of plants was also required in some nurseries.

At the time of writing, successful outplanting of adult and juveniles in tubestock or 14 cm diameter pots has occurred at Angourie (Yuraygir NP; 15 plants), Jones Point (Yuraygir NP; 61 plants), and Serenity Beach (49 plants). A further 200+ plants are to be planted out at Wamberal Lagoon NR in mid-May 2020 (see next section for further details). The approach at all sites is not only to increase overall plant numbers, but also to increase the species' local extent at each site in order to spread the risk of coastal storm erosion. Each plant location is georeferenced and ecological data are recorded, including micro-site details, plant canopy, height, life stage and health. Monitoring will occur monthly for six months then less frequently. Watering will occur as required but will be most frequent during establishment then decrease as plants establish and soil moisture increases in winter.

Wamberal Lagoon Nature Reserve

Sand Spurge was first recorded at Wamberal Lagoon Nature Reserve on the NSW Central Coast in 1894 and has been monitored by NPWS since the early 2000s. Regular monitoring under the SoS program also began in 2016. By 2018, the species was reduced to a handful of individuals and monitoring later in that year found no

individuals. It is thought that the already small population size combined with extreme dry and hot weather resulted in extinction of the population. However, the species is small and is difficult to detect in low numbers, and a greater survey effort could have resulted in increased capacity to detect plants. A recent inspection on 1 May 2020 found that one population had either recovered or persisted undetected. Twenty-two individuals were found in a previously recorded area. Only two of those found were existing records. As these numbers are extremely low a translocation was actioned for the site. The seeds for this project were sourced from the nearest stable populations, including 150 seeds from Seven Mile Beach and Booti Booti NP, and 250 seeds from Mona Vale Headland on the Northern Beaches of Sydney. Seeds were propagated at Bunya Native Nursery and 200 plants have been successfully propagated (Figures 4 and 5) for planting into the recipient site.

The planting strategy involves selecting preferred microhabitats along the beachfront and sand dunes, varying distance from the shoreline, vegetation density, and aspect. A trial will be undertaken using three revegetation treatments: TerraCottem®, water crystals and no treatment (except watering) in each new planting area. The rationale for this is to trial ideal and cost-effective planting out methods to increase plant survival. Plants will be translocated in small clumps to give greater protection from the elements and to increase opportunities for cross pollination. The results of these plantings will not be determined for 12 months, when most plantings are expected to have established and not require further watering or treatment.

The site has also received extensive weed control by professional bush regenerators and volunteers from Spoon Bay Bushcare. The dune system at the site is slowing returning to a natural gradient, where once severe sand blowouts occurred due to the presence of bitou bush (*Chysanthemoides monilifera* subsp. *rotundata*). Weed control will continue at this site for the foreseeable future. Other weeds that potentially impact Sand Spurge habitat include African Daisy (*Gazania rigens*), Sea Holly (*Eryngium maritimum*), and Pennywort (*Hydrocotyle bonariensis*). The translocants will also be monitored for the impacts of native vegetation encroachment (Figures 4 and 5).

The translocation of *E. psammogenet* outlined here should lead to larger, more robust populations across NSW thereby increasing the species' resilience to survive coastal erosion and other threats. With an observed increased frequency and severity of coastal erosion, particularly East Coast Low events, it is hoped that larger populations spread across a variety of microhabitats at sites will minimise the impact of coastal erosion events and result in increased survival.



Figure 4. Propagation of seeds in Bunya Native Nursery.
Photo: Bunya Native Nursery



Figure 5. Propagation of seeds now as tubestock in Bunya Native Nursery. Photo: Bunya Native Nursery

Ecological observations of the endangered *Dentella minutissima* from the Warrego River at Toorale National Park

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Introduction

Dentella minutissima (Rubiaceae) is a succulent, mat-forming herb that grows on sandy riverbanks and grey clay creek beds. It is only known from three areas in New South Wales (NSW): on the Paroo River at Nocoleche Nature Reserve, the Cuttaburra Creek system north-west of Bourke and on the Warrego River from Toorale National Park. The species is listed as Endangered under the NSW Biodiversity Conservation Act 2016 but is not listed at the Commonwealth level.

An opportunity arose to survey for *D. minutissima* along the Warrego River and floodplain, within Toorale National Park and State Conservation Area, on 19–20th February 2020.

Numerous locations were searched from the impoundment of Boera Dam near the northern boundary south to the Warrego River crossing of the Louth Road at Dicks Dam (Figure 1). The species was found at every dam catchment investigated and several locations on the outer floodplain.

Sites found and population estimates

Plant density estimates at Boera Dam and Dicks Dam ranged from 3.9–10.0 plants/m². Therefore, a plant density of 5/m² was taken as a conservative value to give an indication of overall plant abundance at each location. Plant densities of the other locations were estimated at 3 plants/m² for Homestead Dam and Booka Dam and at 1 plant/m² on the Western Floodplain.

Using the above criteria, the combined area of occupancy across all 16 locations where plants were found was estimated to be 6.7 ha (plus significant areas of similar habitat not searched). With the mean plant abundances used, the total estimated plant abundance of *D. minutissima* in Toorale NP is around 290,500. This total includes a significant proportion (possibly up to 35%) which may have reached senescence in being on the driest reaches of suitable habitat and brown in colour with no flowers.

Size range of plants

Plant size ranged from 4–20 cm diameter. The most common plant size found across all locations was around 10–15 cm diameter.

All plants were circular or slightly ovoid in shape with the centre comprising a dense mat of leaves that looks like a single mass, while individual small branches could often be seen radiating out from the edges of the plant. All plants were ground-hugging with the centre ≤1 cm high.

Plant age classes

At all locations *D. minutissima* grew in concentric rings parallel to the receding waterline. The further the plants were from the water the poorer condition they were in, which is indicative of the species colonising new sections of dry ground as the surface water recedes.

The oldest plants, or those furthest away from the waterline, were typically brown in colour with either no or very few flowers (<10). (Most desert members of the genus *Dentella* are ephemeral, so it seems likely that *D. minutissima* is also ephemeral.) Plants that were classified as middle-age, by being located between the closest and furthest belts of plants from water, were characteristically grey in colour across the entire plant and/or around the edges. These plants typically had few flowers (<40). Plants located closest to (but not on) the waterline were categorised as the youngest age class and were mostly green in colour with many flowers (50–300).

Plant root size and length

Soil peds were gently removed from a sample plant until the roots were exposed. This showed *D. minutissima* had multiple main roots of fine structure approximately 5–6 cm long with numerous fine lateral off-shoots up to 5 mm long. This root structure suggests the plant is only accessing soil moisture from the top 10 cm of soil.

Plant community

The Warrego River watercourse vegetation is primarily Coolibah (*Eucalyptus coolabah*) woodland with occasional

Legend

 Total Western Floodplain

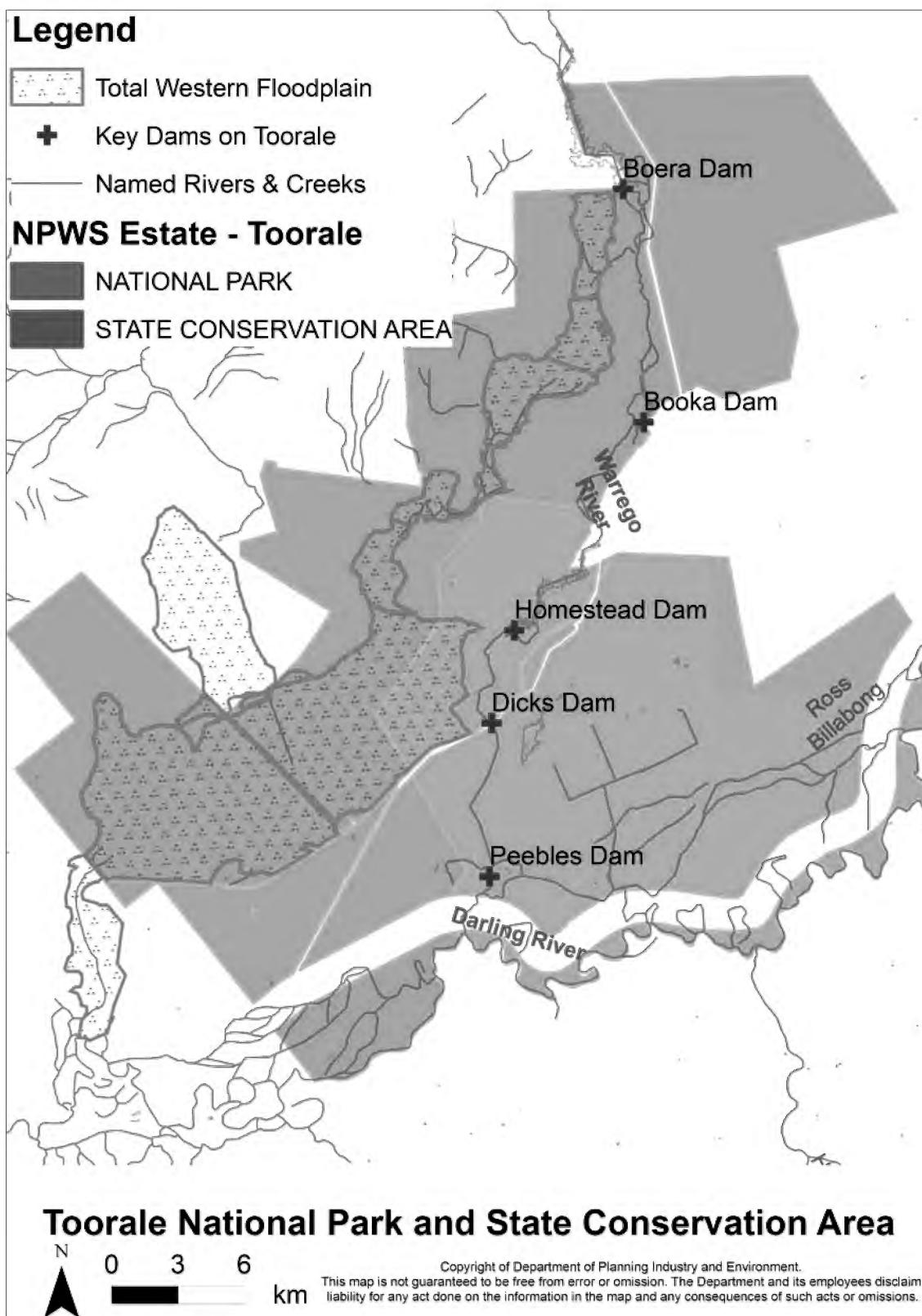
 Key Dams on Toorale

 Named Rivers & Creeks

NPWS Estate - Toorale

 NATIONAL PARK

 STATE CONSERVATION AREA



Toorale National Park and State Conservation Area



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km

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Black Box (*Eucalyptus largiflorens*) further south. This same community type is present along the more ephemeral off-shoots and by-washes from the river. The primary riparian vegetation community occupying the outer floodplain is that of Lignum (*Duma florulenta*) shrublands. Within these communities *D. minutissima* occurred on open mudflats with or without scattered forbs.

Topography and soils

All observations showed *D. minutissima* has a marked preference for flat or near-flat areas. The species was not present on slopes above 2–3°. Soils where the species was found were uniformly grey clays which mostly cracked when dry. The soil surface varied from a silty top layer (such as on mudflats) to fine sands washed or blown over the grey clay from adjacent slightly higher ground.

Figure 1. Toorale National Park and State Conservation Area.



Figure 2. Close-up of *D. minutissima* plant showing minute hairy leaves and small flowers (4–6 mm).
Photo: Darren Shelly



Figure 3. *D. minutissima* growing in dense patches on mudflat at Boera Dam. Green plants are closer to water than grey plants.
Photo: Susan Lamb

Soil surface moisture

All recorded plants occurred on receded waterline areas where the soil surface was dry. At Boera Dam, the closest plants to the current waterline were at least 5 m away. Plants were not growing within 1m of the outer limit of the wet soil line.

Inundation

Common to all located populations was that plants always occurred where water had flowed in and remained for a period of time.

Exposure

D. minutissima was only found in areas that experience full sun.

Tree canopy cover

D. minutissima did not grow under tree canopies where the shade was continual. On several occasions, plants were found growing around the outside edge of tree canopies.

Leaf litter cover

The species was not found in any areas of potential habitat where litter cover was extensive.

Our conclusion was that *D. minutissima* did not occur on areas of suitable habitat where litter cover was over 10%.

Competitive plants

Competitive plants were defined as those species growing in close proximity or physically growing within the spread of the plant itself. Six species were identified: Matted Pratia (*Lobelia darlingensis*), Noogoora Burr (*Xanthium occidentale* [introduced species]), Small

Crumbweed (*Dysphania pumilio*), Desert Sneezeweed (*Centipeda thespidioides*), Lesser Joyweed (*Alternanthera denticulata*) and a clover species.

Associated plants

Two groundcover species typically occurred in association with *D. minutissima* on the large mudflats in exposed positions. These were Hairy Carpet-weed (*Glinus lotoides*) and the introduced species Spreading Heliotrope (*Heliotropium supinum*). Their presence could be used as a rapid site selection indicator for survey.

Disturbance

No observations were made during this survey of any animal grazing on the plant or of any plant that had grazing damage. Given how low to the ground the species grows it is considered that grazing is not a threat.



Figure 4. *D. minutissima* growing in concentric rings from receding water. Brown plants in foreground oldest with grey plants in middle ground closer to water. Photo: Susan Lamb

The only evidence of disturbance to the species in this survey was an occurrence of a plant being trampled by cattle. In this instance, the plant was pushed down into the soil under the hoof but was not enough to kill the crushed area of the plant (since it was now in flower) or the rest of the plant. Therefore, we conclude that a low level of trampling does not necessarily kill plants.

Flooding regime

A check of the WaterNSW real-time data website (<https://realtimedata.waternsw.com.au>) for the nearest river flow meter on the Warrego River at Fords Bridge showed high flows in late April/early May 2019. Fords Bridge is located approximately 50 km north (upstream) of Toorale National Park and so would record flows earlier than the park.

The WaterNSW data also show that another flow came down the Warrego River in November 2019 after significant regional rainfall. This event would therefore be the level from which *D. minutissima* should have started to establish and then follow the receding levels to the point where we observed plants in February 2020.

The time gap from this possible high-water level to the levels observed at the time of survey was approximately 3.5 months. This then is the length of time required to have a total population size of around 290,000 plants across Toorale NP after a period of inundation.

Conclusion

This opportunistic survey has revealed large populations of *Dentella minutissima*, an endangered plant which was previously only little-known from this area. During this survey we were also to make important ecological observations about this species, including its apparent preference for mudflats which were dry on the surface, and damp below (rather than completely damp, or completely dry). Maintaining the appropriate hydrological conditions, including regular inundation, is clearly key to the persistence of this species. Where stock are present, trampling may be a threat to this species – where populations are located on grazing lands fencing of mudflats/ephemeral lagoons may be considered.

Nature needs people, but people need connection: can microbes be the ‘joining dots’?

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Introduction

Microbiota are the support system for life on Earth. The coevolutionary relationship between microbiota and multi-cellular life is essential to fitness. This intimate relationship is under pressure in the Anthropocene; however, there is hope for plants, animals, people and microbiota through conservation and restoration. The success of large-scale conservation and restoration will require scientists and practitioners to motivate and engage the public – perhaps, in one way, by showing them their direct connection to this microbial world.

It all started at the bottom

A long time ago, in an ocean not too far away

Appearing at least 2 billion years before eukaryotes (protists and multi-cellular organisms), single-celled microbiota was the first taxonomic group on Earth. Such microbiota are still the majority of taxonomic and genetic diversity. Today, microbiota are taxa

from four Kingdoms – bacteria, archaea (bacteria-like prokaryotes, often extremophiles), fungi, and eukaryotes (such as microscopic worms). Microbiota are defined as the community of microorganisms in a bounded environment, such as a leaf, some soil, or your gut. It is these microorganisms, particularly the bacteria and fungi as we currently understand, that have allowed the proliferation of multi-cellular life in their microbial world.

Symbiosis and the ‘Way-Back Machine’

Multi-cellular organisms, such as plants and animals, are holobionts, meaning that they are a multi-cellular host with a resident microbiota – the term ‘holobiont’ stems from the Greek *hólos* (whole) and *biont* (unit of life). Multi-cellular organisms cannot survive in the wild as sterile entities because they evolved in a microbial world. In a world where microbes had already inhabited every life-friendly surface, airstream, and fluid for more than two billion years, it was energetically easier for larger lifeforms to coevolve with microbes than to keep them out.

That is, it was easier for them to become holobionts. This is a multi-faceted evolutionary ‘lightbulb moment’. Keeping yourself sterile is energetically expensive, and so is doing all the work of staying alive.

The rise of the holobiont was essentially the rise of outsourcing. The microbial cells of a holobiont roughly equal or outnumber cells of the host (humans are ~43% human cells, 57% microbial). Given the diversity of a holobionts’ microbiota, the collective genome by far outweighs that of the host; the human genome has around 20,000 genes, the human microbiome has 2-to-20 million (Tierney *et al.* 2019). With all of those genes come many functions. For example, in plants, microbes produce many vitamins, bioactive compounds, and phytohormones (Mills *et al.* 2019) that must give them a lot of control over the plant. As this coevolution played out, the holobiont microbiota specialised in ways to maintain their host, such as the ability to control immune systems. Indeed, in plants, diverse leaf-surface microbiota defend against fungal pathogens (Ritpitakphong *et al.* 2016).

Holobionts are ecosystems developed from their own ecosystem, a type of Russian doll, collecting their microbiota as seedlings through soil, babies through birth canals, and children putting every object they can find into their mouths. Indeed, it is the first three years of life that are critical for human microbiota and immune development (Gilbert *et al.* 2018). In ecological terms, a diverse holobiont microbiota keeps pathogens out, just as a diverse forest keeps out invasive species.

Symbiosis in the Anthropocene

Holobiont development is best when coevolved hosts and microbiota can get together, but the relationship is severely hampered by the modern world. Just as large ecosystems can be degraded, so too can holobionts. Taking too many antibiotics or eating simplified diets degrades our diverse gut flora and we become susceptible to opportunistic pathogens. This susceptibility is akin to cutting down a rainforest, effectively inviting in the opportunistic weeds. In the age of degradation, we are seeing myriad diseases related to degraded microbiota exploding in epidemic proportions in plants and in animals and humans alike. Indeed, low-diversity urban green spaces, such as lawns, are more-likely to harbour opportunistic pathogens of plants, animals, and people because the soils are in poor health, with plant life maintained by inputs that are detrimental to beneficial soil microbiota (Mills *et al.* 2020). However, much more research is needed on the mechanistic links between the environmental microbiota and health. That said, the evidence is growing; therefore, conserving and restoring the microbiota of our wider environment will most likely benefit our health and that of the plants and animals that make-up a functionally healthy ecosystem.

Bringing the bottom back to the top

Nature’s welfare is microbial welfare is individual welfare

Microbial communities can be influenced by manipulating environmental conditions for restoration purposes. Restoring landscapes, for example from pasture back to grassy woodlands, influences soil microbiota by simply putting plants into the ground, and can work in wild and urban contexts (Gellie *et al.* 2017; Mills *et al.* 2020). This works because plant species can promote proliferation of specific symbiotic microbiota (Rosado *et al.* 2018). This promotion is by the exudation of carbon compounds and amino acids in the rhizosphere that microbes enjoy, the signatures of which are different for each plant species and thus creates diverse soil environments at the scale of each plant. Diversity of plant exudates is widely used in regenerative agriculture for its benefits to soil nutrition, structure, and biology. Here, multi-species cover crops are used to improve soils in the off-season by keeping the plants’ photosynthesis and positive influence on soil conditions going. Therefore, cover-crops help improve soil structure and microbial diversity and activity, and thus nutrient cycling and disease suppression. Cover cropping is essentially manipulating successional theory to create healthy soils for the following cash crop, and there is ample room to do this in ecological restoration (Sheley *et al.* 2006).

Healthy soils can be disease suppressive because even at that scale the basics of ecology and coevolution apply. Such basics include microbial predator/prey relationships where pathogens and pests are often prey to other microbes in diverse communities (Kinkel *et al.* 2011). However, many restoration efforts are unsuccessful in-part because the soil health has been so heavily degraded. Therefore, the plants don’t get that boost from their coevolved microbiota to survive. For example, plants that have to spend so much energy on trying to balance the soils redox potential because the Eh and pH are now so different will have less energy for growth, defence, and promotion of their symbiotic microbiota (Husson 2013). Such a struggle to survive can leave plants exposed to pathogens. As such, many restoration efforts may require a kind of cover-crop to help restore the soil health before the target community is planted. Promisingly though, soils inoculated with microbiota from target communities can greatly improve the success of a restoration intervention (Wubs *et al.* 2016; Smith *et al.* 2018).

In humans, it is hard to restore the state of the gut microbiota; however, faecal-matter transplants may be successful cures for certain gut disorders, such as *Clostridium difficile* infection (Hvas *et al.* 2019). However, it is the next generation that will really benefit from ecological restoration. Plant and animal health are better in pristine environments and the welfare of nature is important for the welfare of microbiota, which in turn

is important for the health of the plants, animals and beyond to the water, air, and back again. Everything is certainly connected in all directions.

Motivating conservation and restoration action via human welfare

The success of conservation and restoration at large scales will require the support of local communities. Therefore, this support will need to be inclusive of the needs of people (after all, degradation supports economies). We've been informed for many years now that biodiversity provides for our most basic needs – air, food, water etc. So why then, is global action on the biodiversity crisis so inert, but for a few? Certainly, there are entrenched political and economic systems in place that are causing the crisis; however, I do believe in power of the people to act and vote. So, if not governments and corporations (who are responsible), what of the people? Is it that we are too disconnected from the sources of clean air, food, and water to be pro-environmental?

Our nature connectedness moderates the interactions between our nature contact, wellbeing, and pro-environmental behaviour (Martin *et al.* 2020). We may be able to use psychology to increase nature connectedness amongst our communities. Maslow's 'hierarchy of needs' places physiological needs (*e.g.*, air, food, water, sleep) as the base of the 'needs' triangle and safety (*e.g.* health, security, employment) one step above. Only above these base needs do community needs come into requirement such as love and belonging, and esteem. While employment and security are largely out of our hands as a scientific and practitioner community, we can provide valuable information to society.

Our global community needs to be reconnected to nature in ways that connect the dots from our needs for clean air, food, water, and health to nature's welfare in informative ways. This is where understanding of the links between the health of environmental microbiota and those of humans can help. If someone can sit at home and think, 'I'm feeling rather anxious today, potentially because my gut microbiota are unhealthy because I've been eating from a broken food system that has departed from the fruits of healthy soil', or 'I'm not being exposed in my suburb to anxiety-reducing bacteria found in natural soils', then they might also think 'I need to participate in the conservation and restoration of nature' (Luna & Foster 2015; Liddicoat *et al.* 2019).

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Review of the ANPC's Germplasm Guidelines

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The publication 'Plant Germplasm Conservation in Australia – strategies and guidelines for developing, managing and utilising *ex situ* collections' (known as the Germplasm Guidelines) was first published in 1997, and was revised in 2009. The Guidelines provide a science-based best practice guide for the ideal management of *ex situ* (off site) collections of seeds, plant tissues or whole plants. The Germplasm Guidelines are focussed on conservation, particularly of threatened plant species and those at risk of threat, within a highly endemic and biodiverse Australian flora.

The Australian Network for Plant Conservation (ANPC) has been awarded grant funding from The Ian Potter Foundation to revise and expand these Guidelines to include advances in *ex situ* conservation over the last decade. The update is being led by ANPC Project Manager (Germplasm Guidelines), Dr Amelia Martyn Yenson.

The updated Germplasm Guidelines will complement other ANPC publications, such as the recent revision of the 'Guidelines for Translocation of Threatened Plants in Australia' (2018) and the current review of the Florabank Guidelines, a component of the Healthy Seeds Project. The information in the updated Guidelines will be essential reading to those working in conservation agencies, seed banks and gene banks, and botanic gardens.

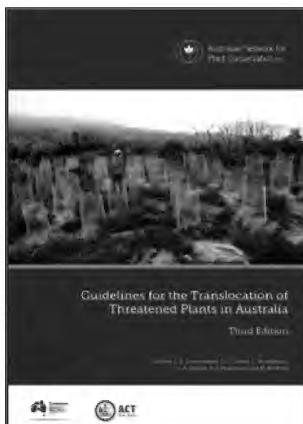


The Germplasm Guidelines include topics such as living collections (field genebanks), vegetative propagation and cryostorage that are not covered in detail by the Florabank Guidelines, which focusses on seed use for ecological restoration. New chapters in the third edition of the Germplasm Guidelines will include genetic guidelines for acquiring and maintaining collections, processes for identifying and conserving non-orthodox seeds (those that can't be dried and banked), and practical strategies for risk management and utilisation of *ex situ* collections.

Publication of the updated Guidelines is planned for mid-2021, with workshops and training materials to follow the launch. Please get in touch with Amelia if you would like any further information about the project.



Amelia Martyn Yenson. Photo: dandesigns.photoshelter.com



Guidelines for the Translocation of Threatened Plants in Australia

The ANPC's brand new third edition is on sale now! Step-by-step information on how to do best-practice translocations, improve translocation success and contribute to preventing plant extinctions.

Third Edition 2018 | Eds L.E. Commander, D.J. Coates, L. Broadhurst, C.A. Offord, R.O. Makinson and M. Matthes. Australian Network for Plant Conservation, Canberra.

For more information and to order, go to <http://www.anpc.asn.au/translocation>

News from the Australian Seed Bank Partnership

Seed banks respond to the bushfires with collecting, research and restoration

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The bushfires have undoubtably created a focus on the value of the Australian environment, more than many of us have seen in recent years. Significant funds have been mobilised for the recovery effort from individuals, business and governments. These demonstrations of solidarity with the plight of the Australian fauna and flora show how much the devastation of these fires has resonated with a global audience. While the story of the fires has been overtaken by the universal impacts of COVID-19, there is still much being done by botanic gardens and seed banks across the country to ensure critical seed storage and germination research work continues. What follows is a snapshot of activities that are already taking place across the Partnership in support of our native flora as it recovers from the devastating fires.

Post bushfire activity in NSW – some early signs of resilience

The catastrophic 2019–2020 summer bushfires impacted heavily on the PlantBank threatened species seed program. Despite these setbacks and COVID-19 restrictions, we have managed to maintain some collecting and are consistently amazed at the resilience and recovery of our native flora. One of our first ‘urgent salvage’ collections after the fires were some critically endangered leek orchids – *Prasophyllum bagoensis* and *P. keltonii*. Some of these orchids had been burnt and their habitat affected by the fire, however several previously hand pollinated plants survived and viable seeds were salvaged for storage at PlantBank. Other terrestrial orchids have been very responsive to the post-fire late-summer rains, and we have made some excellent collections of the critically endangered *Genoplesium superbum* in the Lithgow area and Budawang Ranges.

With well over 400 species impacted by the combination of fire and drought, field reconnaissance for threatened species across NSW is a now very large task. We are being called upon to assist with field assessments and *ex situ* options for restricted plants that are heavily fire/

drought impacted. Recent site assessments included *Zieria odorifera* subsp. *copelandii* from Kaputar National Park, near Narrabri, whose population has reportedly been reduced to only two plants. On this occasion the news was positive, with many more seedlings observed following summer rains. With no seed yet available for collection, cuttings were taken for propagation at the Australian Botanic Garden nursery for inclusion in the garden’s living display collection.

Western Australia’s threatened species receiving much needed help

The Stirling Range National Park is an area recognised for its high species richness, including 30 EPBC listed threatened plant species growing within its borders. In the eastern portion of the park many of the threatened plants are restricted to the peaks and slopes, only occurring in two threatened plant communities.

In December 2019 a lightning-ignited bushfire burnt out a large section of the eastern portion of the park, impacting many of these threatened plant species and the communities in which they grow. This fire followed on from a previous fire in 2018, which unfortunately had already impacted these particular species and communities. The combined impact of these two fires has seen populations of 23 of the 30 EPBC listed threatened species affected, with nine of these species now having no mature plants observed, putting them at a high risk of extinction.

In an attempt to combat these impacts, the Western Australian Seed Centre will use its existing collections for ten of these species to establish seed production areas with the aim of bulking-up seed stocks for future *in situ* recovery work. For those unburnt populations of threatened species that still remain *in situ*, additional conservation seed collections are being planned for the upcoming 2020–2021 collecting season to secure new collections as an insurance against future fires and other threats.

South Australia Seed Centre withdraws seeds from the bank to support bushfire recovery

For two decades Australia's major conservation seed banks have been working closely with the Millennium Seed Bank (MSB) of the Royal Botanic Gardens, Kew to build capacity and collaborate on the conservation of Australia's native flora. Our Partners regularly duplicate collections for many of the species they collect, with these sent to the MSB as an added back up of our in-country collections.

A rare EPBC and SA listed vulnerable pea, *Glycine latrobeana*, was heavily impacted by the Cudlee Creek fires and has now been the recipient of seeds previously stored in the MSB. Thanks to a previous deposit of 12,000 seeds of *G. latrobeana* we made 12 years ago, the South Australian Seed Centre (SASC) was able to withdraw 250 seeds from the MSB, which were shipped back to South Australia to be used for establishing a seed orchard, and in further work restoring populations of the species *in situ*. We have also made withdrawals from our own collections in Adelaide, including *Euphrasia collina* subsp. *osbornii* for propagation testing with various host species.

While it will be some time before many severely impacted species can be considered for collecting, we have visited unburnt areas near the recent fires, securing collections from the critically endangered *Veronica derwentiana* ssp. *homalodonta* and endangered spider-orchids *Caladenia argocalla* and *Caladenia rigida*. Further work is also underway to survey, collect and propagate the endemic Leafy Greenhood *Pterostylis cucullata* subsp. *sylvicola*. One of the populations we were monitoring was burnt in the fire at Lobethal Bushland Park, however we had managed to collect seeds only about a month before the fire.

Over 10,000 ha burnt at Secret Rocks including part of the 9 ha exclosure where the SASC were doing translocations. Additional threatened species work underway near the Secret Rocks inselburg, includes translocations for



Genoplesium superbum resprouting after fire. Photo: Gavin Phillips, Australian PlantBank, Mt Annan

Acacia cretacea, *Brachyscome muelleri* and *Commersonia craurophylla*, among several other plant species. We are also preparing proposals for new projects that will assess the status of threatened species and make new collections on Kangaroo Island.

Tasmania's royal collection goes ahead despite social distancing measures

Although Tasmania was not impacted by serious fires during the summer of 2019–2020, the Tasmanian Seed Conservation Centre had plans to work with a group of fire vulnerable endemics. Tasmania is home to ten species of native conifer, seven of which are endemic. Of these seven, five primitive relictual species from past cool climates are restricted to the Tasmanian highlands and have their stronghold in the Tasmanian Wilderness World Heritage Area. Tasmania's montane conifers are particularly vulnerable to increasing drought and fire risk due to climate change. In fact, some populations have already been lost to fire and may not be able to re-establish naturally due to fragmented distributions, poor dispersal capacity and excessive grazing. Collecting of these species is impacted by the fact that at least three are "masting" species, meaning seed production takes place sporadically every several years. Thankfully, 2020 was a masting year.

The 2020 conifer collecting program aimed to make 21 conservation-sized, seed collections of four key montane conifers from 15 different locations between late March to early May. Key to the success of the program were volunteer teams, experienced arborists and the use of helicopters to access the remote and scattered populations. A supporting collaboration with Tasmanian Walking Company was established and a fundraiser was set up to try and cover the estimated cost of \$36,000. Unfortunately, the pandemic hit just as the program was about to commence and activity was effectively stopped.



James Wood collecting during the 2020 conifer collecting program on the Overland Track in Tasmania. Photo: Royal Tasmanian Botanical Gardens

A two-man collecting team did sample Pencil Pine from the Overland Track in mid-April, harvesting over 8,000 viable seeds from 46 individual stands of trees scattered over 1,000 hectares of land.

Closing remarks

Like many across the country, restrictions on travel has meant collecting and research has been modified or delayed. Our teams look forward to returning to business as usual in the months and years ahead, securing seeds from across the country, and undertaking more storage, germination and conservation research.

We look forward to working with Greening Australia on the implementation of Project Phoenix, and with the ANPC on the Healthy Seeds Project and the revisions to the Florabank and Germplasm Guidelines, two very important tools for Australia in the conservation and use of germplasm from Australian native flora.

Due to the pandemic, the Australasian Seed Science Conference has been postponed until 5–9 September 2021. We thank all our conference partners and sponsors for continuing to support us during this time. For more information on the conference visit: <https://seedscience2021.com.au>



Genoplesium superbum flowers. Photo: Gavin Phillips,
Australian PlantBank, Mt Annan



Critically endangered *Zieria odorifera* subsp. *copelandii* seedlings in wild habitat. Photo: Gavin Phillips, Australian PlantBank, Mt Annan

ANPC Member Profile for APC

Stephen Bell

What is your current position?

I run and manage my own botanical consultancy business in the Hunter Valley of New South Wales, which I established in 1996. Since 2014, I have also been conjoint to the School of Environmental Life Sciences (Centre for Plant Science) at the University of Newcastle, and I currently sit on the NSW Threatened Species Scientific Committee, and have been a member of the NSW Species Technical Group (overseeing the NSW government's Saving Our Species initiative) for the last six years. I have been a member of the ANPC for 25 years, and recently joined its management committee.

What projects are you working on at the moment?

I am always working on a range of conservation-related projects, some of them under paid contract but others I do in my own time for the inherent challenges they provide. For the NSW government, I am involved in several monitoring projects on threatened species, collecting baseline demographic data and then investigating various aspects of their ecology and how this is impacted upon by threats such as drought, fire and grazing. Several of these projects involve searching for additional populations which have proven particularly successful (e.g., *Eucalyptus pumila*, *Lasiopteratum longistamineum*, *Pomaderis reperta*, *Pterostylis chaetophora*). Observations of poor pollination in stands of *Banksia conferta* north of Taree led to a program of remote camera trapping to investigate potential vertebrate pollinators. For industry, I have been monitoring the progress of two translocated threatened orchid species over the past 10 years, documenting how detectability is influenced by various environmental and management factors. I also have an interest in plant taxonomy, and in the absence of available and active working taxonomists am slowly describing new taxa from the Hunter Valley region of NSW.

How did you end up working in plant conservation?

As a fresh graduate with visions of working in the animal ecology field (my Honours degree was in birds), my first professional position was a three month stint with a sand mining company undertaking soil analysis of mined and unmined coastal sands. At the completion of that rather mind-numbing project, my manager advised that there was more work available if I was willing to learn how to identify plants and assess post-mine revegetation. He took me into the field and shouted out plant names



Sampling remnant Yellow Box (*Eucalyptus melliodora*) woodland in the upper Hunter Valley, with *Cymbidium canaliculatum* (part of endangered population) at left. Credit: Colin Driscoll.

while pointing at plants as we drove through the rehab, but they just did not stick. It was only when I had to commence surveys on my own and went through the process of identification that I became enthralled. I soon found that the 800-odd species of Australian birds were no match for the >20,000 plants that awaited finding! From that point on I worked exclusively with plants, following my mine revegetation assessments with a project classifying and mapping vegetation in Yengo National Park for the NSW National Parks and Wildlife Service, and then commencing full time consulting. This then led to numerous classification and mapping projects of varying scales (conservation reserves, offset properties, local government areas), but for the last ten years or more much of my work has involved researching threatened plants and ecological communities.

What is your favourite plant and why?

I don't have a favourite plant, but as a group I really do like those species that only become apparent after some form of habitat disturbance, suddenly appearing in an area that has been otherwise well surveyed. I include in this group those species that may only appear once in a century, not just following recent and regular events. The single population and long-lived small tree *Acacia dangarensis*, for example, was seemingly absent from its only known stronghold on Mt Dangar between 1825 (when Allan Cunningham collected in the area, but did not find it) and 1979 (the first ever collection), despite numerous botanists ascending and collecting on the

mountain during that period. We suspect that a major fire event in the 1950s or 1960s stimulated mass germination from the seed bank, waking it from a >125 year hibernation in the soil. Another example is the low shrub *Commersonia rosea*, which appeared in the thousands following a fire in northern Wollemi National Park a few years ago (and more have surfaced after the most recent fires), but had previously never been recorded there; indeed, it was only described in 2004 following a fire event in similar habitat near Goulburn River National Park. These sorts of events keep botany interesting, reminding me to always expect the unexpected when working with plants.

Why do you think the ANPC network is important and what do you see as our priorities?

Without the ANPC, there is no efficient way for those of us working in the conservation of plant species and communities to keep in touch with happenings across the country. I see the APC bulletin as integral in this, as it is how researchers and managers best communicate their findings. Not everyone is able to access scientific journals to build on the knowledge and experience of others, and without APC there are few other avenues available and accessible to such a wide readership, from on-ground practitioners to academic researchers. Similarly, not everyone has the skills, time or resources to commit

to the preparation of a full length scientific paper on their work, and without a conduit such as APC to disseminate findings others may be reinventing the wheel over and over again.

Priorities for the ANPC should continue to focus on addressing the myriad of threats that impact on our native plants. A large part of this is researching and documenting basic ecological traits, which presents a yawning gap for so many of our species. But in addition to the strong focus ANPC has on legally threatened species, I also think that there should be renewed discussion around the concept of 'rare' plant species: those taxa that are naturally rare in the landscape or occupy rare habitat types. These species are not necessarily threatened like their more glamorous and legislatively-protected cousins, however they do fill an important role in the ecology of an area. Researching these species now may better prepare us for their future management. We should also be thinking and acting long-term in our research, recognising that nature often works to far grandiose time-scales than our individual 50 to 70 effective research years on this planet – once in a century events are sometimes all that is required to maintain a species in its habitat; we should not panic and instigate expensive management interventions before fully understanding the ecology of a species.

Book review

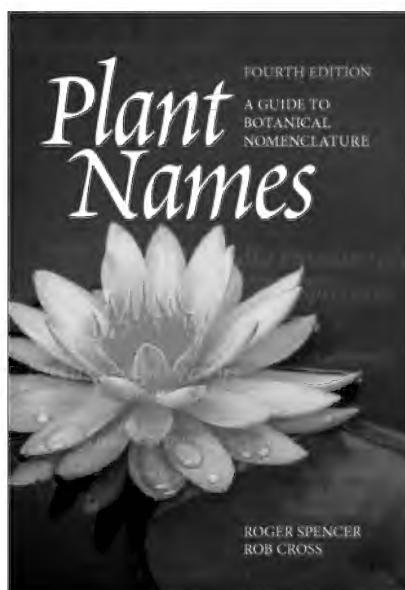
Plant names – a guide to botanical nomenclature. 4th edition

Roger Spencer and Rob Cross.

CSIRO Publishing, Clayton South, Vic. 2020.

A5, 154 pp. ISBN 9781486311446 pbk, 9781486311453 epdf, 9781486311460 epub. RRP \$44.99.

In the midst of the seemingly endless biodiversity crisis, with dismally inadequate policy and investment, it is easy to lose sight of the fronts on which the conservation cause is strong. The problems are both systemic and cultural. A change away from the 'development at any cost' mentality depends, in the long run, not only on winning policy and legal battles, but also on the growth of alternative values and cultural change among people. And in the public values space, there are signs we are not doing too badly. One reflection of this is the continued popular demand for identification resources, particularly for plants and



birds – the most conspicuous wild organisms in most people's lives. And even in the face of the digital deluge, there is still a sustained demand for books – plant ID books in Australia now number in the several hundreds (not all in print) and their production and consumption show no sign of slowing. But where birds of the continent can be dealt with in a single volume and their common names can be made to serve the needs of most general-public end-users, the sheer number of plant species dictates a need to use their scientific names for anything beyond the very local scale.

That need has led most of the State and Commonwealth herbaria at various times to produce ephemeral booklets explaining the basics of plant scientific naming, but it has been the preserve of the Royal Botanic Gardens Victoria (replaced synonym 'RBG Melbourne') to publish a really solid plain-English guide to the meaning and use of plant nomenclature. Each edition of this book has genuinely sold out – a level of public demand for this proverbially dry topic clearly exists.

This fourth edition supersedes earlier ones of the same title authored by Spencer, Cross, and the late Peter Lumley. Those earlier editions remain informative for general principles, but the accumulated recent changes in the two relevant International Codes of Nomenclature make this new edition a worthwhile investment.

The book covers the naming of wild and domesticated plants, why plant names change, their pronunciation, and hints to help remember them. The final section provides a detailed guide to authoritative web sites and published resources on plant names and plant breeders' rights. The sections are logically divided.

Part 1 covers 'Wild plants', starting with the issue of why a global scientific naming system is needed at all ("Nothing is wrong with common names except their lack of precision. Only a scientific name can provide an internationally recognised way of denoting one particular kind of plant"). It then outlines the fundamental principles of that system – the *International Code of Nomenclature for Algae, Fungi and Plants* (ICN, the post-2011 name for the former *International Code of Botanical Nomenclature*) – and the hierarchical ranking system of family-genus-species and so on that it uses. The various reasons for name changes are outlined, although for my money more could have been made of the fact that the overwhelming majority of name changes – elsewhere estimated at 90–95% – reflect actual advances in knowledge as a result of taxonomic revisions and the description of new taxa, rather than the nit-picking priority wars that taxonomists are sometimes accused of.

Some taxonomists have yet to catch up with the revisions to the ICN over the last decade or so that now make 'conservation' of scientific names in general use much easier, even against the challenges of earlier valid names. Those changes also allow the electronic publication of new names, and no longer require the use of Latin for the formal descriptive 'diagnosis'.

Wild plants of course have far more complexity in their descent (lineage) and variability, including ecological and human-use variation, than can be accommodated in any single hierarchical naming system that aspires to be useful at all scales. Meaningful cultural or other classifications may cut across the taxonomic or systematic (evolutionary lineage) classification system and its rules.

We sometimes hear overstatements about the inherent oppressiveness of western science and its imposition of power relations through hierarchical naming systems to suppress alternative ways of looking at the world. This is a baby and bathwater issue. If we (humankind) are to become more ecologically literate about our common planetary heritage, then a globally agreed naming system bridges more gaps than it creates. How it intersects with alternative cultural values and classifications is a matter for dialogue and practice.

Part 2 covers 'Cultivated plants and Cultigens', plants that have been deliberately selected or bred to suit human purposes (mainly in the context of agricultural and forestry use) to a degree that they often no longer conform very well to wild or original genotypes. Here the naming rules have become so different, to meet information needs and the peculiarities of plant breeding and property rights, that a whole separate set has developed – the *International Code of Nomenclature for Cultivated Plants*, or CPC for short. There is overlap with the ICN (for wild plants) to the degree that some plants can be named down to a fine level under either Code, but for the most part they serve different purposes within a similar conceptual framework.

A useful addendum to this section deals with the various Cultivar Registration systems that operate in Australia and internationally, plant trademarks, and the Plant Breeders' Rights system for protecting commercial rights in cultivar names and genotypes.

Part 3 of the book deals with the conventions that govern the use of plant names in writing or print, some of the spelling conventions that govern names in Latin form, and the often over-egged issue of how to pronounce latinised names.

Part 4, and last, provides lists of Australian and global plant name resources, including lists (not all fully current) of valid scientific names, regional and global checklists and Floras, cultivar registration bodies, plant name authors, and other nomenclatural miscellania.

Put this book together with its Melburnian companion 'Name that Flower: the identification of flowering plants' (3rd edition, Ian Clarke & Helen Lee, 2019, MUP), and you have a core botanical resource that helps you make sense of the plethora of images, descriptions and names in all those field guides and Floras.

Bob Makinson

News and conferences

ANPC News

ANPC's Australian Native Seed Survey Report released!

The Australian Native Seed Survey Report was launched by the Threatened Species Commissioner Dr Sally Box on 31 March 2020. The report details the full results of the national survey capturing the behaviours and views of a wide range of participants in the native seed sector – which the authors say are not all encouraging.

'Worryingly, the report highlights the concerns of the sector that future demand for seed will be difficult to meet from the wild' said Martin Driver from the ANPC. 'This is due to the high costs of seed collection and the lack of seed from a broad range of the species that are critical for restoration. The recent bushfires have made this situation worse'.

Seed production of native seed offers some hope, but currently lacks the capacity to meet demand. 'Seed production areas (SPAs) are an increasingly important supplier of seed for restoration, landscaping and bush food markets' said Dr Paul Gibson-Roy from Kalbar Resources. 'SPAs are locations where we cultivate native species for their seeds, like agricultural crops. They can produce seed in higher quantities and quality that is much easier to collect than in the wild. Their continued development will be critical to meeting seed needs and preserving wild populations'.

Download the Report here

<https://www.anpc.asn.au/media-releases/where-will-the-seeds-come-from/>



Threatened Species Commissioner Sally Box launching the ANPC's The Australian Native Seed Survey Report.
Photo: Sally Box

SAVE THE DATE! 13th Australasian Plant Conservation Conference (APCC13) – Albury NSW, 19–23 April 2021

The ANPC is excited to announce that the 13th Australasian Plant Conservation Conference (APCC13) will be held in Albury from 19–23 April 2021 and hosted by Albury City Council. Stay tuned for more information soon. To keep up with the latest news, keep an eye on the conference website

<https://www.anpc.asn.au/conferences/apcc13/>

2019's Seeds for the Future Forum presentations now online

The first round of videos from the Seeds for the Future Forum have been published on AABR's RegenTV YouTube page, including the Introduction, some of the Q and A sessions plus those by: Tein McDonald: Greater Sydney or Lesser Sydney? Putting restoration standards into practice; Paul Gibson-Roy: National Seed Survey, aspirations vs reality. Are the issues relevant to Sydney?; and the ANPC's Martin Driver: Healthy Seeds – What's needed? The current barriers and future opportunities. Watch the videos here

<https://www.youtube.com/c/regenTV>

An update of the Florabank Guidelines – National guidelines for best practice native seed collection and use

As part of the Healthy Seeds project, an update of the Florabank Guidelines has commenced to ensure practitioners are aware of, have access to, and are using up-to-date science and guidance materials for best-practice native seed management in ecological restoration. Listen to ANPC Project Manager Lucy Commander's presentation on the update of the Florabank Guidelines (*which was to be presented at the postponed Australasian Seed Science Conference in Canberra in April 2020*).

<https://www.youtube.com/watch?v=b9kKxYNSzZ4&feature=youtu.be>

Revision of the ANPC's Germplasm Guidelines

The publication '*Plant Germplasm Conservation in Australia – strategies and guidelines for developing, managing and utilising ex situ collections*' (known as the Germplasm Guidelines) is currently being revised with grant funding from The Ian Potter Foundation. The updated Germplasm Guidelines will complement the recent revision of the '*Guidelines for Translocation of Threatened Plants in Australia*' and the current review of the Florabank Guidelines.

The update is being led by ANPC Project Manager Dr Amelia Martyn Yenson. A steering committee composed of ANPC, CSIRO, Australian Seed Bank Partnership, Australian Grains Genebank, Royal Botanic Garden Sydney, Australian National Botanic Gardens, Royal Botanic Gardens Victoria, Australian Tree Seed Centre, Botanic Gardens Australia and New Zealand and NSW Dept of Planning, Industry and Environment representatives has been formed to oversee the project. We are currently inviting potential chapter authors and reviewers for the publication
<https://www.anpc.asn.au/germplasm-guidelines-review/>



2019–2020 Bushfires – resources pages

The ANPC is compiling resource pages on plants and fire after the devastating 2019–2020 Australian bushfires, with information about bushfire in Australia, plant responses to fire, and conservation/restoration post-fire. Read about what federal and state governments are doing in response to the bushfires, and find other related links, media articles and papers from past editions of Australasian Plant Conservation. Find out how plants and ecological communities recover from fire and what we can all do to help. This includes not planting or seeding in burnt and naturally regenerating areas in the period immediately after fire, and waiting to see what regenerates in the medium to long term and seeking expert advice, before deciding what interventions are needed. The highest priority in the short term is to assist natural regeneration where necessary to control feral predators, herbivores and invasive plants. Reconstruction actions such as seed banking, direct seeding and planting etc. should only be undertaken where necessary and following expert advice.

<https://www.anpc.asn.au/plants-and-fire-2020/>
<https://www.anpc.asn.au/bushfire-2019-2020-resource-page-2/>

ANPC's submission to the independent review of the Environment Protection and Biodiversity Conservation Act 1999

The second independent review of the EPBC Act commenced on 29 October 2019. The review will be led by Professor Graeme Samuel AC, supported by a panel of experts. A report will be presented to the Minister for the Environment within 12 months of commencement of the review. Download the ANPC's submission here
<https://www.anpc.asn.au/wp-content/uploads/2020/04/ANPC-EPBC-Act-review-comments-20-April-2020.pdf>



Pomaderris delicata, listed as Critically Endangered under the Environment Protection and Biodiversity Conservation Act 1999.
(Photo: Neville Walsh)

Australasian Seed Science Conference – new dates confirmed: 5–9 September 2021

As a result of the ongoing impact of the COVID-19 virus, the Australasian Seed Science Conference was postponed. The Organising and Scientific Committees are pleased to announce that the Conference will now be held from 5–9 September 2021, and would like to extend their appreciation to those who have contributed abstracts and time to developing the conference program. For more updated information please visit the Conference website and join our mailing list to keep up-to-date with new developments
<https://seedscience2020.com.au/>

AUSTRALASIAN
Seed Science
Conference

5 - 9 September 2021
Australian National Botanic Gardens
Canberra, ACT, Australia
E: assc2021@arinex.com.au
W: www.seedscience2021.com.au

Plant cuttings – plant conservation news from around Australia

Editors' note: News excerpts are clipped from a diversity of sources. To read the articles in full follow the links attached to each clipping. The views expressed in these articles are those of their authors and do not necessarily represent the opinion of the ANPC.

Provisional list of plants requiring urgent management intervention – Dept of Agriculture, Water and the Environment

The Wildlife and Threatened Species Bushfire Recovery Expert Panel, on 23 April 2020, released a list of 471 plant species identified as the highest priorities for urgent management intervention to support recovery from the 2019–2020 bushfires. The plants span a variety of vegetation types and include rainforest trees and shrubs like Monga Waratah (*Telopea mongaensis*) and plants from subalpine vegetation, such as the Critically Endangered Bredbo Gentiana (*Gentiana bredboensis*). Some species were considered threatened before the fires, and the fires have now likely increased their risk of extinction. Many other fire-affected plant species were considered secure before the fires but have now been burnt across much of their range and may lack an ability to recover without support. Some species, like the Forrester's Bottlebrush (*Callistemon forresterae*), Betka Bottlebrush (*Callistemon kenmorrisonii*), and Grey Deua Pomaderris (*Pomaderris gilmourii* var. *cana*) are at imminent risk of extinction because all of their known or modelled range has been burnt and they are exposed to other stressors such as drought, high fire frequency or severity, or disease.

<http://www.environment.gov.au/biodiversity/bushfire-recovery/priority-plants>

Help track Environmental Recovery from the Bushfires

Citizen scientists can contribute to understanding how the natural environment recovers from the devastating 2019–2020 bushfires by uploading your observations to the Atlas of Living Australia. Please check fire-affected areas have been declared safe by the land manager before you enter.

<https://inaturalist.ala.org.au/projects/environment-recovery-project-australian-bushfires-2019-2020>

New website to link citizen scientists into Bushfire Recovery

CSIRO has launched the Citizen Science Bushfire Project Finder website to enable members of the public to contribute to projects ranging from air quality, to identifying and confirming animal and plant sightings while maintaining safe social distancing practices. People can also get involved online by identifying animals in camera images. The Project Finder also features a geographic filter enabling users to identify available projects in their area.

https://biocollect.ala.org.au/bushfire_recovery#isCitizenScience%3Dtrue%26max%3D20%26sort%3DdateCreatedSort

Regional Vegetation Guides now available

Ten Regional Vegetation Guides developed by NSW Local Land Services are now available. The guides describe vegetation formations, endangered ecological communities and site managed species in each region to enable rapid assessment of the potential status of native vegetation in the field. The guides will be of particular benefit to councils undertaking roadside vegetation assessments using the Rapid Assessment Methodology (developed through the Environmental Trusts Linear Reserves program, which included the Council Roadside Reserves project), as they provide valuable detail on typical vegetation structure and key diagnostic features of vegetation communities throughout NSW.

<https://www.lls.nsw.gov.au/help-and-advice/growing,-grazing-and-land/travelling-stock-reserves/conservation-of-tsrs>

Botanic Gardens Biosecurity Network launches new website

The Botanic Gardens Biosecurity Network website aims to act as a focal point for providing practical information and advice to staff of botanic gardens, community interest groups and members of the public to develop awareness, knowledge and skills to contribute to general biosecurity surveillance activities. You can help by sharing the website with your networks.

<http://extensionaus.com.au/botanicgardensbiosecurity>

Rabbits, kangaroos and seedling survival in Endangered buloke woodlands: Project update – Threatened Species Recovery Hub

Grazing and browsing by herbivores like rabbits and kangaroos can be a serious impediment to restoring degraded ecosystems. A TSR Hub project used a field experiment to investigate survival and browsing damage to seedlings in the Endangered buloke woodlands vegetation community. The findings show that complete protection from browsers with wire guards was the only treatment that resulted in a net positive growth of seedlings over one year, while 95% of unguarded seedlings were dead or significantly damaged. Mere survival is not enough for seedlings exposed to strong browsing pressure. To survive and reach maturity they need to attain a height and bulk where they are no longer vulnerable to herbivores. In buloke woodlands this has been estimated to take around nine years or more. The knowledge gained will also benefit the conservation of other woodland communities where active or natural regeneration is impacted by browsing.

<https://environment.us16.list-manage.com/track/click?u=1d841a64839b7d68557961aef&f=3d15d4dd8cande=dfcd4c0b45>

Mapping threatened species and threatening processes across northern Australia - NESP Northern Australia Environmental Resources Hub

Northern Australia's rich and unique biodiversity faces many threats including weeds, feral animals and inappropriate fire regimes. Knowledge gaps around where threatened species are located and their sensitivity and exposure to various threats can limit the effectiveness of conservation actions and create uncertainty for sustainable development in the north. Hub research aiming to address these knowledge gaps has produced spatially explicit data and maps that can be used to inform conservation policy and assessments as well as guide decision-making about how to manage or mitigate threats. Project leaders Dr Anna Pintor (James Cook University) and Associate Professor Mark Kennard (Griffith University) have produced distribution maps for more than 1,400 species of conservation concern, hotspot maps showing species richness, and maps of key threatening processes including ~250 weed species, feral animals and wildlife diseases

<https://www.nespnorthern.edu.au/projects/nesp/prioritising-threatened-species/>

Tasmania's montane conifers, including King Billy and pencil pine, fruit for first time since 2015

Theories abound, but there is no hard and fast way to tell when certain kinds of trees will fruit — the only thing you can be sure of is that it does not happen very often. Tasmania's montane conifers — several species of which are endemic to the state — last propagated, or masted, in 2015, sending researchers scrambling to collect their seeds. Now the trees are at it again, but the seeding is not just confined to the Apple Isle, or even Australia. "Masting events like this appear to be global, with conifers seeding in New Zealand and other parts of the world," said the Tasmanian Seed Conservation Centre's (TSCC) James Wood.

https://www.abc.net.au/news/rural/2020-01-14/tasmanian-conifers-fruit-for-first-time-in-years/11858284?fbclid=IwAR1oiX9eeS9zt6EYGsp32KldmqP4n_L1fHIoYp4v2CF8TuqAvc0iNDXtbA

Gondwana-era rainforest stand of nightcap oak devastated by unprecedented bushfire

A rare stand of Gondwana-era rainforest plants that has survived for tens of millions of years, has now been ravaged by fire in the wet, sub-tropical rainforests of northern New South Wales. Unlike the successful mission to save the Wollemi Pine in the Sydney Basin, the fate of the nightcap grove has received almost no attention. The nightcap oak *Eidothea hardeniana* is one of 20 extremely rare ancient plant species found in a small area in the Nightcap National Park, north of Lismore.

<https://www.abc.net.au/news/2020-01-18/gondwana-era-nightcap-oak-devastated-by-bushfire/11877770>

The seedbank preserving rare native species

The Victorian Conservation Seed Bank at Melbourne's Royal Botanic Gardens offers something of a Noah's Ark for rare plants. Megan Hirst, plant ecologist and seedbank officer at the gardens explains how it all works and their work in saving the *Nematolepis wilsonii* after the Black Saturday fires in 2009.

<https://www.abc.net.au/radio/melbourne/programs/evenings/seedbank/11895642>

Australian government adviser urges threatened species overhaul after bushfires

A senior adviser to the federal government on threatened species has backed calls for the creation of a national scientific monitoring system after the bushfire crisis to help fix Australia's "very uneven" record in protecting endangered wildlife. Helene Marsh, chair of the national threatened species scientific committee and an emeritus professor of environmental science at James Cook University, said the scale of the ecological tragedy had made Australians more aware of the risks facing the country's unique animals and plants and provided an opportunity to improve conservation. With fires still burning, scientists warn it is too early to have a clear picture of the devastation, but preliminary government data suggests more than 100 threatened animal and plant species have lost at least half their habitat and more than 300 have lost more than 10%. The impact on most species not currently listed as threatened is yet to be assessed.

<https://www.theguardian.com/environment/2020/jan/26/australian-government-adviser-urges-threatened-species-overhaul-after-bushfires>

Post-bushfire logging makes a bad situation even worse, but the industry is ignoring the science

Australians have expressed extraordinary levels of concern about our native animals and the ability of environments to recover from the recent catastrophic wildfires. The bush and the animals it supports are a core part of Australian culture and psyche. Yet, just as the trees are sprouting green shoots and the first signs of forest recovery are beginning to emerge, the forest which survived the fire is threatened by post-fire logging. Multiple independent, peer reviewed studies show logging forests after bushfires increases future fire risk and can render the forest uninhabitable for wildlife for decades or even centuries.

<https://www.abc.net.au/news/2020-01-29/logging-bushfire-affected-areas-australia-increases-fire-risk/11903662>

After the fires, are we invited to moral community with trees?

Over the summer months, Australia has witnessed the devastation of forests and the immolation of wildlife on an unimaginable scale. Across Australia, more than 10 million hectares have burned — including at least 80 percent of the Blue Mountains world heritage

area and more than half of the world heritage listed Gondwana rainforest. These are all areas that have, historically, simply been too wet to burn. More than a hundred threatened species have been brought closer to extinction because of these fires, and it's estimated that a billion animals burnt to death in these summer infernos.... It's no wonder so many of us found ourselves grieving deeply. The emotional or even the tragic content of these fires has been — understandably — reserved for the loss of human life and home and livelihood, and for the loss of some non-human animals. But why do we grieve fauna and not flora? Why do we not grieve the trees — not because of what they do for us (or what they cannot now do for us), but because of a depth of relationship that we have with trees?

<https://www.abc.net.au/radionational/programs/theminefield/after-the-fires,-are-we-invited-to-moral-community-with-trees/11901494>

Why Australia's severe bushfires may be bad news for tree regeneration

Blackened tree stems are all that remain in many post-fire images of eastern Victoria. The charred, often leafless trees are a testament to the severity of this season's bushfires, which have had a devastating impact on the state's biodiversity. How the trees respond to the fires is crucial to environmental recovery since most of the burned ecosystems are forests, and trees are the backbone of forests. Until recently, we could be confident that most of the trees in our forests would recover from most fires, but that confidence is wavering.

https://phys.org/news/2020-01-australia-severe-bushfires-bad-news.html?fbclid=IwAR2wpD6Ue6lWeiDD9NT_KmXBim0kQ9bLlpI1UKhiR5M9UtLfOEkxabVtQ7E

Bushfires: eligibility rules relaxed for threatened species

Due to the overwhelming number of plants and animals that have already perished in bushfires this summer, the Federal Environment Department has moved to make it easier to get species listed as "threatened". Normally, nominations for the official threatened species list only happen once a year. But the Threatened Species Commissioner has confirmed to Saturday AM that the department will now welcome any new nominations, at any time, as an emergency measure.

<https://www.abc.net.au/radio/programs/am/bushfires:-eligibility-rules-relaxed-for-threatened-species/11920436>

Waking up - Australian bush begins its long bushfire recovery

Fire has sent some of Australia's most popular national parks into an eerie slumber, but new growth is breaking through the blackness. When plants burn, a few things can happen. Some are killed by fire. Others lose their leaves, or become branded with scorch marks, their spindly branches seemingly without life, but that does not mean they are dead. Under the blackened bark and ashen soil, the plants grow on, and eventually, green emerges. In the Australian bush, "resprouters" have all the ingredients they need to come back from fire on their own. While the bushfire season is far from over, in the New South Wales Blue Mountains, nature's recovery is already underway.

<https://www.abc.net.au/news/2020-02-01/natural-bushfire-recovery-underway-binna-burra,-blue-mountains/11916742>

The Plant Messiah - reviewed by Peter Bernhardt

Carlos Magdalena is a botanical horticulturalist at Kew Gardens in London. He propagates rare and endangered plants to maintain living and scientific collections. In his book he describes his numerous collecting trips and his attempts to care for and propagate his specimens. The Plant Messiah is the inspirational story of a man who has devoted and risked his life to saving biodiversity. Professor of Botany Peter Bernhardt reviews The Plant Messiah.

<https://www.abc.net.au/radionationals/programms/scienceshow/the-plant-messiah-%E2%80%93-reviewed-by-peter-bernhardt/11918346>

NSW wildlife recovery plan to stress protection of unburnt areas

The Berejiklian government is stepping up food drops for endangered species and aerial shooting of some feral animals as part of efforts to help save dozens of native plants and animals brought closer to extinction by the state's unprecedented bushfires. The Wildlife and Conservation Bushfire Recovery plan, obtained by the Sun-Herald, also updates the impact of fires that have scorched 5.3 million hectares so far. Blazes have hit the habitat of 84 of the most vulnerable animals, while 46 threatened plant species have more than 90 per cent of their recorded range in fire zones, it said. Energy and Environment Minister Matt Kean said staff are still

assessing the full effect but it was clear fires have had "a devastating impact", with 37 per cent of the national parks estate burnt.

<https://www.smh.com.au/environment/conservation/nsw-wildlife-recovery-plan-to-stress-protection-of-unburnt-areas-20200131-p53wp6.html>

Non-native marine algae detected in Botany Bay

NSW Department of Primary Industries (DPI) has recently detected two non-native marine seaweed pests in NSW waters for the first time, and community members have been asked to report any sightings. The species are the red macroalga *Grateloupia turuturu* and *Pachymeniopsis lanceolata*. This is the first detection of *Grateloupia turuturu* in NSW waters and the first detection of *Pachymeniopsis lanceolata* in Australia. *Pachymeniopsis lanceolata* is a large, flesh-pink to dull muddy red, sheet-like plant (50–200 cm long, 30–50 broad) with a very small attachment to the rocks and a broadly forked blade which gets battered over time...*Grateloupia turuturu* is a long, narrow, large and wavy, crimson red seaweed, (up to 150 cm long, and 20 cm broad) with a tiny attachment and stalk. <https://www.nationaltribune.com.au/non-native-marine-algae-detected-in-botany-bay/>

Self Improvement: How plants respond to bushfires

The recent bushfires have had a devastating impact on plants, how can they ever recover? Take a listen to this week's lesson with Dr Brett Summerell, Chief Botanist at the Royal Botanic Garden.

<https://www.abc.net.au/radio/sydney/programs/drive/self-plants/11933998>

Not all weeds are villains. After a fire, some plants – even weeds – can be better than none

The Invasive Species Council and other observers have argued for weed control as a major priority following bushfires, to promote the recovery of wildlife and damaged ecosystems. The time is right, some say, to wage a serious offensive against weeds before they re-establish and this opportunity is lost. But perhaps we shouldn't be so hasty to villainise all weeds. There is growing recognition that weeds can, in some cases, support a range of critical ecological functions.

<https://theconversation.com/not-all-weeds-are-villains-after-a-fire-some-plants-even-weeds-can-be-better-than-none-130702>

'Immortal clones': Plea for recovery plan to aid ancient rainforests

This season's bushfires damaged Gondwana rainforests, including trees with lineages dating back tens of millions of years, placing at risk the highest concentrations of threatened species in NSW. Robert Kooyman, an ecologist and honorary research fellow at Macquarie University, said the unprecedented fires in northern NSW had likely killed at least 10 per cent of the world's only wild stand of nightcap oak. Other endangered species such as peach myrtles - possibly the oldest organisms on the planet with the "immortal clones" living a thousand years or more - and minyon quandongs were also badly hit, he said. "We have serious issues in this forest," said Dr Kooyman, who discovered and documented the nightcap oak two decades ago. "Recovery action will need to be planned very carefully, and given a reasonable amount of funding."

<https://www.smh.com.au/environment/conservation/immortal-clones-plea-for-recovery-plan-to-aid-ancient-rainforests-20200209-p53z3f.html>

Impact of fires on World Heritage Areas

On Thursday 13 February, the Department released maps of the impacts of the 2019-20 Bushfires on three World Heritage Areas: Greater Blue Mountains (NSW), the Gondwana Rainforests of Australia (NSW/Qld) and the Old Great North Road (NSW, part of the Australian Convict Sites World Heritage Area). The maps indicate that bushfires have had the following impact on these properties:

- Gondwana Rainforests of Australia (NSW, Qld) – approximately 54 per cent affected
- Greater Blue Mountains Area (NSW) – approximately 81 per cent affected

Other World Heritage Areas (Budj Bim Cultural Landscape (Vic), Fraser Island (K'gari) (Qld), Wet Tropics (Qld) and Tasmanian Wilderness) have also been affected
<https://www.environment.gov.au/biodiversity/bushfire-recovery/research-and-resources> .

Australia's major botanic gardens united to assist ecosystem restoration in response to recent bushfires

The impact of the recent bushfires on our native plants and animals has been severe. Millions of hectares of native habitat have been burnt, putting at risk the survival of plant and animal species. While much of the Australian bush and its plants are well adapted to fire, the ferocity and extent of the bushfires this summer, and predicted

frequency for coming years due to climate change, are unprecedented. Some plants will recover depending on the timing and extent of rains, but some ecosystems require carefully managed intervention. For those animals that did not perish in the fires, loss of plant habitat and food presents a particular risk. However, it is critical that any reintroduction of native species to the environment delivers the right plant species, in the right place, at the right time, in a manner that has no detrimental impacts on the environment.

<https://www.seedpartnership.org.au/wp-content/uploads/2020/02/CHABG-statement-bushfire-recovery-capability.pdf>

Seven Billion Burnt Trees

Horrific statistics ricochet around the world, sparked by the Australian bushfires. Half a billion animals, now likely to be closer to a billion. Millions of acres, thousands of homes, 33 human lives. I follow these, I feel these, and a voice in the back of my head asks 'how many trees, how many shrubs? How many plants?' I can't help but feel a sense of incomprehension. Why is the impact of fires on plants not making the news; rarely the subject of fundraising campaigns; not being spoken of as anything other than habitat or hazard? Why, when nothing exists without plants, does our society continue to choose not to pay serious attention to their existence?

<https://theplanthunter.com.au/botanica/seven-billion-burnt-trees/?fbclid=IwAR3btSbzLMV9W61S24OzQUCr9LhACmS0d8jdwCby11521aDMkLnH-HYPo>

A peek inside Canberra's hidden bank

While others were packing precious photos and mementos during the summer bushfires, ready to evacuate if necessary, there was one person in Canberra packing eskyes full of seeds. These seeds are the insurance policy against the massive loss of vegetation (8.4 million hectares across NSW, Victoria, Queensland, South Australia, Western Australia and Tasmania) we've witnessed this summer due to climate change-related bushfires. Tom North is Curator of the National Seed Bank (NSB), a small but vital service tucked away in the Australian National Botanic Gardens (ANBG). The NSB is a quiet achiever. While worldwide climate change protests have been growing larger and louder, employees and volunteers at the NSB have been diligently collecting seed for conservation and research.

https://hercanberra.com.au/cpcity/a-peek-inside-canbellas-hidden-bank/?fbclid=IwAR2RzHo2X_Pu_FRvy_EB3Aj_LbxGnp4ajjxMTo-oP98LRy0Td4oSH9X4xzw

'Don't waste a crisis': bid to rebuild national seedbanks gathers pace

Restoring 10 per cent of the vegetation destroyed in this season's bushfires would require more than \$800 million in new seeds – "magnitudes" more than the funding available so far. Paul Della Libera, the director of seed services at Greening Australia, said 18 million hectares had burnt this fire season across the country. Even though much regeneration would happen naturally, the challenge for restoring especially threatened species remained huge, he said. "You can't have bushfire recovery without seed, just as you can't build a national road network without concrete," Mr Della Libera said. The national capacity to produce seed "doesn't exist at the moment in the way that we need it to". <https://www.smh.com.au/environment/sustainability/don-t-waste-a-crisis-bid-to-rebuild-national-seedbanks-gathers-pace-20200217-p541kn.html>

The plan to create a 1000km continuous corridor of bushland known as the 'Gondwana Link'

Conservationists, property owners and community groups are working side by side in southern Western Australia to create a 1000km continuous corridor of bushland. It conjures an ancient time when Earth's supercontinents were being rearranged; when Gondwana – the great southern landmass that eventually broke into Australia, Africa, South America, Antarctica, Arabia and the Indian subcontinent – was covered in lush rainforests; and when the evolutionary paths of the plants and wildlife of the Northern and Southern hemispheres diverged. It is fitting, then, that the word features in the name of one of Australia's biggest conservation projects: Gondwana Link.

<https://www.australiageographic.com.au/topics/science-environment/2020/02/the-plan-to-create-a-1000km-continuous-corridor-of-bushland-known-as-the-gondwana-link/>

Over 100 eucalypt tree species newly recommended for threatened listing

The Threatened Species Recovery Hub has undertaken a conservation assessment of every Australian eucalypt tree species and found that over 190 species meet internationally recognised criteria for listing as threatened: most of these are not currently listed as threatened. Associate Professor Rod Fensham at the University of Queensland said the team assessed all 822 Australian eucalypt species against the criteria set by the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species™.

The results have just been published in the scientific journal Biological Conservation. "Our assessment found that 193 species, which is almost one quarter (23%) of all Australian eucalypt species, meet criteria for a threatened status of Vulnerable, Endangered or Critically Endangered," said Associate Professor Fensham. "This is very concerning as eucalypts are arguably Australia's most important plant group, and provide vital habitat to thousands of other species."

http://www.nespthreatenedspecies.edu.au/news/over-100-eucalypt-tree-species-newly-recommended-for-threatened-listing?fbclid=IwAR3-XCwBy_UBv9atgpiQnFZlgjhvejK49BcW3utPd1tiuSITYFngz_N95xE

Impact of fires on Threatened Ecological Communities

On 19 February 2020, the Department released an initial list of threatened ecological communities which have more than 10% of their estimated distribution in areas affected by bushfires in southern and eastern Australia between 1 July 2019 and 11 February 2020. Preliminary results indicate that of the 84 nationally listed threatened ecological communities:

- Four have more than 50% of their estimated distribution within the fire extent
- Three have more than 30%, but less than 50%, of their estimated distribution within the fire extent
- Thirteen have more than 10%, but less than 30%, of their estimated distribution within the fire extent.
- Another seventeen have some of their estimated distribution within the fire extent.

This analysis compares maps of fire extent from state fire agencies with maps of the estimated distributions of ecological communities protected under the Environment Protection and Biodiversity Conservation Act 1999.

<https://www.environment.gov.au/biodiversity/bushfire-recovery/research-and-resources>

Study finds large numbers of eucalyptus trees are in serious decline

A study published in the journal Biological Conservation has found close to a quarter of all eucalyptus trees are threatened species. The paper identified Western Australia as having the worst rate of decline. Experts say reduced land clearing and concerted efforts at reforestation is the only way to prevent further losses.

<https://www.abc.net.au/radio/programs/am/study-finds-many-eucalypt-species-are-in-serious-decline/11982742>

Thousands of feral horses to be removed from Kosciuszko national park after bushfires

About 4,000 feral horses will be removed from Kosciuszko national park in New South Wales as part of an emergency response to protect the alpine ecosystem after large areas were devastated by bushfires. The move would be the largest removal of horses in the park's history, said the NSW environment minister, Matt Kean. Announcing an agreement between "horse lovers and national-park lovers", Kean said a priority would be to catch and remove the animals, but he would not rule out that some might have to be killed. The NSW National Parks and Wildlife Service (NPWS) said three areas in the north of the park covering about 57,000 hectares would be targeted – Nungar plain, Cooleman plain and parts of Boggy and Kiandra plains. <https://www.theguardian.com/environment/2020/feb/20/thousands-of-feral-horses-to-be-removed-from-kosciuszko-national-park-after-bushfires>

Eucalyptus trees in our suburbs spark safety debate among scientists and citizens

Downed trees have caused widespread disruption for thousands of residents recovering from severe storms in recent weeks, fuelling renewed debate about how to better protect communities from the elements. As the clean-up continues, concerns around the planting of eucalyptus trees in urban areas are being voiced. But experts have warned that, despite the hype, the risk to lives and property would be even greater if the gum trees were gone. Royal Botanic Gardens chief botanist Brett Summerell has noticed an increase in anxiety around eucalypts in recent months.

<https://www.abc.net.au/news/2020-02-21/eucalyptus-trees-scientists-unpack-anxiety-over-widow-maker/11984280>

Nature's 'first responders' go for green

Blackened and burnt trees and shrubs throughout two conservation parks devastated in the Cudlee Creek fires have begun re-sprouting following recent rains. Both Charleston and Porter Scrub Conservation Parks were completely burnt during the December fires, leaving trunks charred and the ground black and bare, with the parks currently closed for safety reasons. But after just six weeks, these parks are revealing that nature's 'first responders' are throwing out shoots and bursting from the ground as the process of forest recovery begins.

<https://www.naturalresources.sa.gov.au/adelaidemtloftyranges/news/200225-regenerating-bushland-charleston-porter>

Want to help save wildlife after the fires? You can do it in your own backyard

...Despite the focus on animals, it is plants, making up 1,336 of the 1,790 species listed as threatened, that have been hit hardest. Early estimates are that the fires had severe impacts on 272 threatened plant species. Of these, 100 are thought to have had more than half of their remaining range burnt. The impacts on individual plant species is profoundly saddening, but the impacts on whole ecosystems can be even more catastrophic. Repeated fires in quick succession in fire-sensitive ecosystems, such as alpine-ash forests, can lead to loss of the keystone tree species. These trees are unable to mature and set seed in less than 20 years....It is difficult to know how best to "rescue" threatened plants, particularly when we know little about them. Seed banks and propagation of plants in home gardens can be a last resort for some species. You can help by growing plants that are indigenous to your local area. Look for an indigenous nursery near you that can provide advice on their care. Advocate for mainstream nurseries, your council and schools to make indigenous plants available to buy and be grown in public areas.

<https://theconversation.com/want-to-help-save-wildlife-after-the-fires-you-can-do-it-in-your-own-backyard-131896>

Call to end logging of 'protective' native forests in wake of bushfire crisis

A group of forestry and climate scientists are calling for an immediate and permanent end to the logging of all native forests across Australia as part of a response to climate change and the country's bushfire crisis. In an open letter, the group said forestry workers involved in logging in native forests should be redeployed to support the management of national parks. A briefing document to back the letter, coordinated by The Australia Institute thinktank, argues logging in wet eucalypt forests promotes more flammable regrowth.

<https://www.theguardian.com/environment/2020/feb/26/call-to-end-logging-of-protective-native-forests-in-wake-of-bushfire-crisis>

Travelling Stock Reserves (TSR) State-wide Plan of Management released after consultation with stakeholders

The release of the Plan of Management is the final stage of the TSR review which commenced as a result of the Crown Lands Management Review. The review recognised that TSRs may no longer be used for their original purpose and recommended a review to identify where TSRs are, what they are used for, by whom and how often. This plan responds to those review findings. This is the first state-wide Plan of Management for TSRs. It recognises them as a single resource of State significance and provides for a consistent management approach, in line with community expectations. The plan establishes the need for shared responsibility and collaborative funding to raise the revenue needed to manage TSRs for these purposes.

<https://www.lls.nsw.gov.au/news-and-events/news/statewide/2020/travelling-stock-reserves-state-wide-plan-of-management>

Do you have data to shape Australia's Threatened Species Index for 2020?

The Threatened Species Index (TSX), launched in 2018, is calling for new data on threatened and near-threatened plants. Do you count threatened creatures in a standardised way? Your data may be gold for us and Australia! We are collecting monitoring data for the TSX until 31 May 2020. The TSX tells us how Australia's threatened species are faring overall and which groups of species and where are most in need of our help.

<https://tsx.org.au/2020/03/02/do-you-have-data-to-shape-australias-threatened-species-index-for-2020/>

Logging is due to start in fire-ravaged forests this week. Here's why that's a bad idea

David Lindenmayer explains why logging in fire-ravaged forests will harm Australia's wildlife. New South Wales' Forestry Corporation will this week start "selective timber harvesting" from two state forests ravaged by bushfire on the state's south coast. The state-owned company says the operations will be "strictly managed" and produce timber for power poles, bridges, flooring and decking. Similarly, the Victorian government's logging company VicForests recently celebrated the removal of sawlogs from burnt forests in East Gippsland. VicForests says it did not cut down the trees – they were cut or pushed over by the army, firefighters or road crews because they blocked the road or were dangerous. The company said it simply removed the logs to put them "to good use".

<https://www.australiageographic.com.au/topics/science-environment/2020/03/logging-is-due-to-start-in-fire-ravaged-forests-this-week-heres-why-thats-a-bad-idea/>

National parks mapping to aid forest recovery from bushfires in NSW

The NSW government is conducting a major investigation into the damage that bushfires caused to national parks in the Hunter and elsewhere across the state. About a million hectares burnt in national parks in and around the Hunter Region. Google Earth mapping, compiled by the government and University of NSW, has revealed the extent of bushfire damage to the canopy in national parks. The mapping shows the damage caused by mega-fires in Wollemi and Yengo national parks. These fires sent huge amounts of smoke across the Hunter in December and January during westerly winds. The notorious Wollemi fire, known as the Gospers Mountain blaze, set a record for being the biggest forest fire in Australian history.

<https://www.canberratimes.com.au/story/6657678/colour-coded-maps-show-bushfire-damage-in-national-parks/?cs=14231>

Thousands of hectares added to Queensland national park

More than 3300 hectares of bushland including potential koala habitat will be added to Mount Walsh National Park outside Maryborough, Environment Minister Leeanne Enoch said on Friday. That now makes Queensland's national park estate roughly the size of Tasmania, Ms Enoch said. The state government confirmed it bought seven freehold parcels of land allowing 3392 hectares to be added to Mount Walsh National Park. "The Mount Walsh area contains a high number of rare native plant species, and the new area presents potential habitat for numerous vulnerable species including the koala," Ms Enoch said.

<https://www.smh.com.au/politics/queensland/thousands-of-hectares-added-to-queensland-national-park-20200306-p547qe.html>

Kangaroo Island Flora

Sophie meets two generations of Kangaroo Island women who have dedicated their lives to the local flora in one of Australia's biodiversity hotspots. Kangaroo Island is one of Australia's biodiversity hotspots because of its high diversity of local plant species (over 1000 species) including 60 endemic species, and because conservation is essential to preserve the natural values. If you want to learn about the plants of KI, then one place you might end up is a non-descript house in the main town, home

to Bev Overton who set up the official Kangaroo Island Regional Herbarium in a shipping container in her backyard. Born on KI, Bev spent the best part of her life as a botanist in the field, documenting, collecting, mapping and sharing her knowledge on KI plants.

<https://www.abc.net.au/gardening/factsheets/kangaroo-island-flora/12030748>

Seed banking after bushfires an insurance policy against extinction for some native plant species

The future of some of Australia's endangered native plants hangs in the balance following the bushfire crisis that saw almost 5.5 million hectares of land burned in New South Wales alone. But scientists hope seed banking could provide hope that affected plant species will flourish again. The chief botanist for the Australian Botanic, Royal Botanic, and Blue Mountains Botanic Gardens, Brett Summerell, said the bushfires posed a real possibility that some plant species already under threat may be lost from the landscape. "Looking at the maps and the extent of the fires that have happened, and judging from the intensity of some of the fires, it is likely that there will be a number of plant species — particularly those with restricted distribution — that may be under threat of extinction," Dr Summerell said.

https://www.abc.net.au/news/2020-03-07/is-seed-banking-an-insurance-policy-for-native-plants/12021190?fbclid=IwAR3D3Z7oVzyD4Gtb_vIULyq9cHd55vZdrMlskYkYeV7_RPl9qaipMuUMek

Entire hillsides of trees turned brown this summer. Is it the start of ecosystem collapse?

The drought in eastern Australia was a significant driver of this season's unprecedented bushfires. But it also caused another, less well known environmental calamity this summer: entire hillsides of trees turned from green to brown. We've observed extensive canopy dieback from southeast Queensland down to Canberra. Reports of more dead and dying trees from other regions across Australia are flowing in through the citizen science project, the Dead Tree Detective. A few dead trees are not an unusual sight during a drought. But in some places, it is the first time in living memory so much canopy has died off. Ecologists are now pondering the implications. There are warnings that some Australian tree species could disappear from large parts of their ranges as the climate changes.

https://theconversation.com/entire-hillsides-of-trees-turned-brown-this-summer-is-it-the-start-of-ecosystem-collapse-126107?utm_source=twitterandutm_medium=bylinetwitterbutton&fbclid=IwAR0MT7zm5NS_PloQmnO0f2PNYhr3h_uyHJuBK_ueL_Q6B_ZCMPInxZ3tzCk

WA Government puts a 12-month halt on logging of mature karri forests in the South West

The Western Australian Government has placed a 12-month freeze on the logging of "two-tier" karri forests in the state's wooded South West region. Two-tier karri forests are defined as mixed-age forests comprised of mature trees and younger regrowth trees. The Forest Products Commission (FPC) manages the logging of WA's native forests and has excluded two-tier karri forests from its native-timber harvest plan for 2020. The decision has been met with celebration from conservationists and a backlash from the local timber industry.

https://www.abc.net.au/news/2020-03-09/wa-government-12-month-stop-mature-two-tier-karri-forest-logging/12037488?utm_source=abc_newsandutm_medium=content_sharedandutm_content=linkandutm_campaign=abc_newsandfbclid=IwAR2GuRtJuMaVxzIYkuZDB1_iET9EAknO3hfauOPW-9Cj3ZMXUGumY-Mhk

Namadgi extensively damaged, but showing pockets of hope

On Friday 6th March, Maddie Clegg, biodiversity campaigner from the Conservation Council, attended an assessment tour of Namadgi National Park, to see first-hand the impact of the fires this summer. The visit brought together representatives from local member groups, national parks staff and the local community. The purposes of the trip were to gain an understanding of the impacts of the recent fires, determine what recovery efforts are currently in place and what will be required in the coming months. Whilst some areas remained largely unburnt, providing crucial habitat for remaining local species, other areas are extensively damaged.

<https://conservationcouncil.org.au/namadgi-extensively-damaged-but-showing-pockets-of-hope/>

The politics of trees

Types of trees, locations of trees, numbers of trees: everyone's got an opinion when it comes to trees and fire danger. Trees are also an essential part of slowing climate change, by capturing carbon. Our guests say Australia needs a national conversation about trees. And there is criticism that good money, and good opportunities, have been wasted on some tree planting programs. Guests: Professor David Lindenmayer Ecologist from the ANU's Fenner School of Environment and Society; and Assoc Professor Patrick O'Connor Ecological economist, University of Adelaide.

<https://www.abc.net.au/radionational/programs/latenightlive/the-politics-of-trees/12047342>

Rare tangle orchid found in rainforest gully at risk of local extinction due to bushfires

Kevin Heyhoe lost his house in the summer's bushfires, but he says he is more gutted to see the destruction of a rainforest gully on his property that contained an unusual species of orchid. Mr Heyhoe discovered tangle orchids (*Plectorrhiza tridentata*) on his property at Bete Bolong North in East Gippsland in December, but major fires soon struck the area. "I lost my fences and I lost the house, but I was more gutted to lose the rainforest gully," he said. Trust For Nature conservation officer Paul Harvey went to the site, making note of rocks in the area because all of the vegetation was gone. "Sure enough, the orchid's gone," Mr Harvey said. "There is no trace of it, and their host plants, the water gums or kanookas, have all been toasted."

<https://www.abc.net.au/news/2020-03-13/rare-orchid-found-in-gippsland-rainforest-at-risk-after-bushfire/12052458>

Mount Canobolas rises from the ashes with some new finds

Two years of work following a devastating fire have seen Mount Canobolas State Conservation Area emerge with 79 new species recorded, including two new plants that exist nowhere else in the world. National Parks and Wildlife Service Ranger Steve Woodhall said the results captured over several surveys were largely thanks to the efforts of local NPWS staff and volunteers of the Orange Field Naturalist and Conservation Society. "More than 70% of Mount Canobolas State Conservation Area was affected by an intense bushfire in February 2018. "While this fire impacted the community and the park heavily, 2 years later we have emerged with new knowledge about what exists in this unique ecosystem. Most exciting has been the identification of two new ground orchid species, the pink spider orchid and the Canobolas leek orchid. The Canobolas leek orchid hasn't been seen since the last major fire back in 1982 – at that time it remained an undescribed species.

<https://www.environment.nsw.gov.au/news/mount-canobolas-rises-from-the-ashes-with-some-new-finds>

Dead Tree Detectives - Citizen Science

Calling all Dead Tree Detectives! It might seem a bit grim to be searching for and recording where you find dead trees, but this valuable work helps scientists understand where trees are dying, why they are dying and importantly, how to stop other trees from meeting a similar fate! To be part of the project, visit the Dead Tree Detective Website. All you need is a smartphone to take photos of the trees and record their location via gps. Once

you have taken the photo, you can submit it to the team and help collect data for this vital project. The project is contributing data to the Atlas of Living Australia.

<https://www.abc.net.au/gardening/dead-tree-detectives---citizen-science/12076458>

How fungi's knack for networking boosts ecological recovery after bushfires

The unprecedented bushfires that struck the east coast of Australia this summer killed an estimated one billion animals across millions of hectares. Scorched landscapes and animal corpses brought into sharp relief what climate-driven changes to wildfire mean for Australia's plants and animals. Yet the effects of fire go much deeper, quite literally, to a vast and complex underground world that we know stunningly little about, including organisms that might be just as vulnerable to fire, and vital to Australia's ecological recovery: the fungi.

<https://theconversation.com/how-fungi-s-knack-for-networking-boosts-ecological-recovery-after-bushfires-132587>

'The forest is now terribly silent': land set aside for threatened species entirely burnt out

New photos showing the devastating impact of bushfire in east Gippsland forests are sparking renewed calls for the Victorian government to rethink its approach to logging and bring forward the promised 2030 phase-out of the native timber industry. A series of before-and-after pictures by the photographer Rob Blakers show the impact of last summer's fires on the slopes of Mount Kuark, known as one of the few places in Australia where cool and warm temperate rainforests grow together. All shots were taken within a 48,500-hectare area that the premier, Daniel Andrews, announced in November would be immediately exempt from logging to protect the greater glider and other threatened species.

<https://www.theguardian.com/environment/2020/mar/22/the-forest-is-now-terribly-silent-land-set-aside-for-threatened-species-entirely-burnt-out>

Life is coming back to Porter Scrub Conservation Park after the Cudlee Creek fires

Burnt trees and shrubs are re-sprouting and insects and birds are returning. This park is home to up to 23 species of conservation significance, including the nationally vulnerable Bassian Thrush and Clover Glycine, which is vulnerable in SA. AMLRNRMB and National Parks and Wildlife Service South Australia are monitoring the impacts and the park will re-open when it's safe.

<https://www.facebook.com/watch/?v=195627185208995>

Bushfire-affected Adelaide Hills habitat to get helping hand

Woodland bird species devastated by the Cudlee Creek bushfire will get a \$1.2 million boost thanks to a new landscape scale habitat restoration program funded by the State and Federal governments. A large number of significant native trees were lost in the Cudlee Creek fire which provided valuable habitat for declining woodland bird species. The Woodland Bird Resilience Program will safeguard future populations through habitat restoration to support these unique bird species. The planting will commence immediately and run for two years. The project will provide for native tree and understorey seedlings, stock proof tree guards, labour costs, maintenance for plantings and capacity to engage landholders.

<https://minister.awe.gov.au/ley/media-releases/bushfire-affected-adelaide-hills-habitat-get-helping-hand>

New work to support bushfire recovery and COVID-19 impacts

On 3 March the Australian Government announced an additional \$2 million in funding to the Threatened Species Recovery Hub to deliver research and scientific advice to help support wildlife and habitat recovery efforts following Australia's bushfire crisis. The funding comes from the Australian Government's National Environmental Science Program. As bushfire recovery research needs will exceed the capacity of this funding, we will direct attention to the most strategic and pressing needs in consultation with: the Australian Government's Wildlife and Threatened Species Bushfire Recovery Expert Panel; state, territory and Australian Governments and key stakeholders.

<http://www.nespthreatenedspecies.edu.au/news/new-work-to-support-bushfire-recovery>

Post-fire ecological stocktake

An outside observer leaves Australia shell-shocked after touring burnt forest regions. And a resident ecologist has been doing a stocktake of what's survived and what hasn't in his region. Guests: Adam Welz, writer, photographer, and film-maker specialising in environmental issues Based in Cape Town. Mark Graham, ecologist with the Nature Conservation Council, a NSW peak body. Fire and biodiversity specialist, based on the NSW North Coast.

<https://www.abc.net.au/radionational/programs/saturdayextra/post-fire-ecological-stocktake/12050408>

Ask Fuzzy: What is a transformational weed?

If you've travelled across the Eden Monaro districts recently, you may have noticed great swathes of land covered by African Lovegrass (*Eragrostis curvula*). It's an attractive plant, with soft feathery seed-tops and generic tussock round leaves. It's an example of a "transformational weed", which get their name from the drastic changes they bring to a landscape. Similar examples are Gamba grass (*Andropogon gayanus*) and Buffel grass (*Cenchrus ciliaris*). Transformational weeds such as Lovegrass are early and rapid colonisers of degraded country. As the drought has laid bare so much land, Lovegrass has hopped in to displace other plants. From there, it smothers competitors, turning the rich blend of what was once there into a monoculture. The loss of diversity disrupts the local ecology, with knock-on effects on other plants, insects and wildlife.

<https://www.canberratimes.com.au/story/6698210/what-is-a-transformational-weed/?cs=14225>

Farming and conservation groups call for \$4b post-pandemic jobs boost

A coalition of more than 80 landcare, environmental, farming and conservation groups has written to state and federal governments proposing the creation of 24,000 jobs in land rehabilitation as part of a post-pandemic stimulus package. Under the proposal, landscapes and infrastructure damaged by the recent drought and bushfires would be rehabilitated in part by people who had lost jobs as a result of the coronavirus. The jobs package would cost \$4 billion over four years, according to the proposal that has been endorsed by groups including the National Farmers Federation, the NSW Farmers Federation and the Nature Conservation Council, or about 1000 full-time jobs for each \$100 million spent.

<https://www.smh.com.au/environment/conservation/farming-and-conservation-groups-call-for-4b-post-pandemic-jobs-boost-20200402-p54gjc.html>

After the Fire

Costa pays a visit to the Blue Mountains Botanic Gardens at Mount Tomah, within the Blue Mountains World Heritage area, to investigate how the landscape has begun to regenerate after the bushfires of late 2019. Incredible efforts by the team at the botanic gardens and fire fighters saw much of the collection at the gardens saved from the Gospers Mountain mega-fire in December 2019, the surrounding conservation area, also managed by the gardens, was not so lucky. Around 90% of this 180-hectare space was heavily impacted, the landscape burnt and blackened as far as the eye can see. But closer inspection reveals smatterings of green, signs that the bush is slowly recovering.

<https://www.abc.net.au/gardening/factsheets/after-the-fire/12115378>

When Jamie fell in love with the mountains

Distinguished Professor Jamie Kirkpatrick has been crawling across lawns for more than 70 years, it's just that this one is on the top of a mountain and is full of plants from the cretaceous.

<https://www.abc.net.au/radionationals/programs/offtrack/jaimie-mountains-repeat/12059702>

Fears for wildlife recovery after bushfires as coronavirus crisis stymies scientists' fieldwork

Scientists are being forced to shut down or scale back fieldwork to assess the impact of last summer's devastating bushfires on threatened species amid the coronavirus crisis, prompting concerns it could affect wildlife recovery. Several universities have shut down fieldwork to comply with restrictions on travel and physical contact and government agencies working on the recovery have had to scale back some of their operations. Urgent work such as feral-animal baiting has been able to continue in many fire-hit regions, and departments have adjusted their working methods to use local contractors rather than fly their own teams into locations such as Kangaroo Island, where there have been calls for a ban on non-essential travel.

<https://www.theguardian.com/australia-news/2020/apr/05/fears-for-wildlife-recovery-after-bushfires-as-coronavirus-crisis-stymies-scientists-fieldwork>

Impacts of the coronavirus pandemic on biodiversity conservation

The COVID-19 pandemic is impacting all parts of human society. Like everyone else, conservation biologists are concerned first with how the pandemic will affect their families, friends, and people around the world. But we also have a duty to think about how it will impact the world's biodiversity and our ability to protect it, as well as how it might affect the training and careers of conservation researchers and practitioners. As editors of *Biological Conservation*, we have heard first-hand from colleagues, authors, and reviewers around the world about the problems they are facing, and their concerns for their students, their staff, and their research projects.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7139249/>

'Years of effort to be wasted': Angst over volunteer lockouts in forests

Coronavirus restrictions have halted volunteer monitoring of logging industry activity and important recovery programs for the east coast's fire ravaged forests. Invasive Species Council chief executive Andrew Cox said curbs on volunteer-based programs to remove invasive weeds could cause "years of effort to be wasted". "Almost all the volunteer weeding programs around the country [run by councils and community groups] have been halted," Mr Cox said. "Weeding is critical now, particularly in eastern Australia after the bushfires, particularly since we also got a lot of rainfall in recent weeks and the weeds are going gangbusters. Weeds thrive in disruption [from fires] and bad land management and they're getting a free hand during this period."

<https://www.smh.com.au/politics/federal/years-of-effort-to-be-wasted-angst-over-volunteer-lockouts-in-forests-20200409-p54ii5.html>

Coastal Native Design

Josh visits a landscape designer whose coastal home garden celebrates the local flora. Planting palate limited to those plants found growing in the adjacent coastal dunes.

<https://www.abc.net.au/gardening/factsheets/coastal-native-design/12136428>

Growing Community

Sophie discovers how growing seedlings for revegetation projects has brought together four families in suburban Adelaide. As we all know, everybody needs good neighbours, and neighbourly relations are easily achieved when common interests are shared. In Cumberland Park, Adelaide, a shared passion has done more than bring residents together – it's helped revegetate precious bushland. Under the Trees for Life tree growing scheme, neighbours Jasmin, Jake, Patrick and Laura Mallon, Julie and Scoob Raynes and Nick and Sue Carboon have turned parts of their patches into propagation stations for South Australian indigenous trees and shrubs.

<https://www.abc.net.au/gardening/factsheets/growing-community/12136768>

Wollemi Pine citizen science survey growing global

Hundreds of people around the world are helping Wollemi Pine researchers understand more about Australia's ancient pine by completing the I Spy A Wollemi Pine citizen science survey. Since it was discovered in 1994 growing deep in a canyon in the Blue Mountains, the curious conifer has become available to many parts of the world. Wollemi Pines can now be found growing in parks, gardens and backyards across the globe. The I Spy A Wollemi Pine citizen science survey was launched in December 2019 by Dr Cathy Offord based at the Australian Botanic Garden Mount Annan and Dr Heidi Zimmer from the NSW Department of Energy, Environment and Science. Dr Offord and Dr Zimmer are trying to identify the hottest, coldest, wettest and driest places where Wollemi Pines can grow to gain important insights into the environmental tolerances of this special tree.

<https://www.rbgnsydney.org.au/Stories/2020/Wollemi-Pine-citizen-science-survey-growing-global>

Setting the stage for invasive species research

The old adage prevention is the best medicine applies to many things, including invasive species – plants, animals or even diseases that are not native to Australia, but once they arrive can quickly become a problem. Stopping new, environmentally harmful invasive species from arriving and establishing in Australia is one of the most cost-effective actions we can take to protect our native species from invading weeds, feral animals and diseases.

With the coronavirus now a global pandemic most people around the world now understand the need to act hard and fast when a dangerous new virus emerges. The same case can be made for the arrival of invasive species.

<https://invasives.org.au/blog/setting-the-stage-for-invasive-species-research/>

The rise and rise of feral deer in Australia

A group of Victorian land managers giving evidence to a Senate inquiry into the impacts of feral deer, pigs and goats put their case bluntly. "Feral deer do not need managing for sustainable hunting, they need extermination." And this. "To call deer a 'game' species is a misnomer, they are a destructive, invasive feral pest species that are multiplying out of control." Feral deer are creeping across Australia and little is being done by federal or state governments to limit their impacts or stop their spread. But a Senate Environment and Communications Committee is looking into the wide-ranging issues.

<https://invasives.org.au/blog/the-rise-and-rise-of-feral-deer-in-australia/>

\$5 million funding boost for bushfire affected wildlife in New South Wales

Remediation action to secure the future of the Wollemi Pine, feral predator control, feeding support and targeted captive breeding programs are among the NSW bushfire recovery priorities to receive \$5 million from the Morrison Government's \$50 million Wildlife and Habitat Recovery package. The NSW Government has worked closely with the Federal Government's Wildlife and Threatened Species Bushfire Recovery Expert Panel to identify a number of high priority needs following the devastating impacts of Australia's bushfires on native animals, plants and ecosystems. "While some on-ground activities are being modified in accordance with COVID-19 restrictions, there remains a strong focus on bushfire recovery and the challenges facing our animals and plants," Federal Minister for the Environment, Sussan Ley said.

<https://minister.awe.gov.au/ley/media-releases/5-million-funding-boost-for-bushfire-affected-wildlife-in-nsw>

Almost 500 Australian plant species and 200 invertebrate species need urgent help

Almost 500 Australian plant species and 200 invertebrate species need urgent help to support their recovery after last summer's disastrous bushfires. The list was released yesterday by the Wildlife and Threatened Species Bushfire Recovery Expert Panel, which had already identified more than 100 animal species needing priority care. The call for urgent action comes after Australia's most comprehensive mammal database revealed this week that populations of key Australian mammal species have crashed by about a third (33 per cent) since the mid-1990s.

<https://www.abc.net.au/radiational/programs/breakfast/plant-and-invertebrate-species-need-urgent-help/12179978>

Buried under colonial concrete, Botany Bay has even been robbed of its botany

The HMS Endeavour's week-long stay on the shores of Kamay in 1770 yielded so many botanical specimens unknown to western science, Captain James Cook called the area Botany Bay. During this visit, the ship's natural history expert Joseph Banks spoke favourably of the landscape, saying it resembled the "moorlands of England" with "knee-high brushes of plants stretching over gentle and treeless hills as far as the eye could see". Since then, Kamay has become an icon of Australia's convict history and emblematic of the dispossession of Indigenous people from country. However, memories of the pre-British flora have largely been lost. Ongoing research drawing on ecological data, and Indigenous and European histories, reveals what this environment once looked like. It shows many of the assumptions about the historical landscape we hold today may actually be wrong.

<https://theconversation.com/buried-under-colonial-concrete-botany-bay-has-even-been-robbed-of-its-botany-135315>

Bushfires leave 470 plants and 200 animals in dire straits – government analysis

More than 400 plants and nearly 200 invertebrates need urgent attention after the bushfire crisis, new analysis for the federal environment department has found. Freshwater mussels, shrimps, burrowing crayfish, land snails, spiders, millipedes, bees, dragonflies and butterflies were among the invertebrates whose ranges have been severely affected by the unprecedented fires through spring and summer. The most severely affected species have had at least 30% of their range burned, and in some cases the figure was much higher. Publication of the list of 471 plants and 191 invertebrates comes as business groups and governments emphasise the need to reduce bureaucracy around environmental assessments as part of the economic recovery from the coronavirus crisis.

<https://www.theguardian.com/environment/2020/apr/26/bushfires-leave-470-plants-and-200-animals-in-dire-straits-government-analysis>

Rare and shy Sticky Emu-bush likes to be disturbed

Here's the thing. A plant can be rare and under threat of extinction, but also require disturbance to grow. That is, fencing off its habitat and leaving it alone will only exacerbate the problem. The Varnish Bush, an emubush called *Eremophila visicida*, from sandy loam country between Latham and Pindar in Western Australia, is one such species. Despite being found over a relatively wide area in the midwest and wheatbelt of Western Australia and being a 'disturbance opportunist', the Varnish Bush is listed as Critically Endangered in that State.

<http://talkingplants.blogspot.com/2020/04/rare-and-shy-sticky-emu-bush-likes-to.html>

Other conferences, courses and events

Updates available at

http://anpc.asn.au/other_conferences_and_events

Hands Healing the Land *Booja-Moort-Kaartdijin* Community Science Conference – Alfred Cove WA, postponed to November 2020

Be inspired! Join land care practitioners, scientists and community volunteers come together to celebrate how community make a difference in caring for our unique flora and fauna, learn from traditional owners and build community. This one day event will bring speakers from all walks of ecological restoration land care, natural resource management and environmental education who will share their experiences and give you a chance to learn, connect and build community.

<https://rehabilitatingroe8.org/hands-healing-the-land/>

1st International Plant Translocation Conference – Rome Italy, 22–25 February 2021

The University of Roma Tre will host the 1st International Plant Translocation Conference from 22–25 February 2021 in Rome. The conference will be a unique occasion for conservation biologists from around the world to share their experiences, successes and misfortunes in restoring threatened plant species. Many plant species around the globe are threatened or already extirpated from the wild as a result of habitat loss, pollution, alien invasive species and climate change. Translocation is now a common conservation, sometimes highly successful, sometimes dramatically discouraging. Conservation biologists, ecologists, taxonomists, geneticists, practitioners, policy makers and others need a place to share experiences improve translocation science and practice to deliver more effective conservation outcomes.

<http://host.uniroma3.it/eventi/IPTC2021/>

NSW Nature Conservation Council's 2020 Bushfire Conference – Sydney NSW, postponed to May 2021

In light of public health advice on the Novel Coronavirus (COVID-19) we are unfortunately postponing the Nature Conservation Council of NSW's Bushfire Conference scheduled for the 19–20th May 2020 at the NSW Teachers Federation Conference Centre in Sydney until next May 2021 (date to be confirmed). We have made this decision for the safety of our delegates and to assist in safeguarding the wider community. The rationale for deferral to May 2021 is primarily due to the uncertainty about the ongoing impact of COVID-19 and the potential for bushfires to cause disruption to presenters and delegates during the 2020-21 fire season. We recognise that many people were anticipating that this "Cool, warm, hot: the burning questions" conference would provide an important opportunity to discuss and learn at first hand ways to better understand and manage the effects of fire in our cherished environment, particularly after the recent devastating fire season. The conference will still act as a valuable platform, with additional time for recovery, reflection and learnings from the fires to be shared in May 2021.

<https://www.nature.org.au/healthy-ecosystems/bushfire-program/bushfire-conference-2020/>

Global Botanic Garden Congress - Melbourne VIC, new dates announced 27 September – 1 October 2021

Botanic Gardens Conservation International (BGCI)'s Global Botanic Garden Congress is the only global congress dedicated to botanic gardens and is a key event in the calendar for botanic garden leaders and staff. It is an opportunity for the botanic garden community to come together and share information and experiences. Held every three or four years the Congress includes internationally renown plenary speakers and sessions covering topics relevant to botanic gardens such as policy, education, governance, conservation and research.

<https://www.bgci.org/our-work/services-for-botanic-gardens/bgci-congresses/bgci-global-botanic-garden-congresses/>

2nd Australian Weeds Conference - Adelaide SA, new dates announced 10-13 October 2021

The Weed Management Society of South Australia (WMSSA) with the support of Council of Australasian Weeds Societies Inc. (CAWS) have decided to postpone the 22nd Australasian Weeds Conference (22AWC) due to the COVID-19 Coronavirus pandemic. The WMSSA and CAWS look forward to co-hosting the event next year and are excited to announce a new date at our

venue Adelaide Oval on 10-13 October 2021. We are now looking forward with optimism to 2021. By delaying the event, we will progress with confidence in our ability to host the conference that everyone knows and loves at a time when society is more positive and secure (note that we will also continue to monitor all advice from the Australian Government and heed their future directive).
<http://wmssa.org.au/22awc-new-dates-announced/>

Research round up

COMPILED BY TOM LE BRETON

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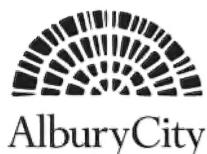
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Image: *Acacia terminalis* subsp. *terminalis* (credit Gavin Phillips, Royal Botanic Gardens Sydney).



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